VALUE-DETERMINING PHYSICAL PROPERTIES AND CHARACTERISTICS OF

DOMESTIC WOOLS

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CONTENTS

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SUMMARY

This study was made for the purpose of determining the accuracy of visual appraisals for wool grades, for clean wool yield, and for staple length.

Its purpose was also to test the accuracy of sampling and testing methods used to estimate grade and yield.

To accomplish these aims, visual appraisals of grade and yield, made by Government appraisers and a committee of trade representatives, were compared with the actual wool top resulting from the processing of the grease wool appraised.

Some of the conclusions reached after making these comparisons were:

(1) Coring with a 1-1/4-inch cutting edge provided the best sample for determining yield; that this method of determining yield proved more accurate than visual appraisal or testing core samples of larger or smaller cutting edges; there appeared to be no appreciable difference between end or side core sampling patterns.

(2) Better methods are needed to sample for the determination of moisture content in commercially scoured wool.

(3) Reasonably accurate estimates of average staple length, and the range of staple lengths within a graded lot, can be obtained by using the measurement techniques described in this study.

(4) As the average diameter of the wool becomes coarser, the average number of crimps per inch becomes fewer; but crimp is not always a criterion of the absolute degree of fineness.

(5) In comparing Noble and French combing, there appeared to be no appreciable difference in fineness and yield, but data suggested that Noble combing produced a slightly longer top.

(6) There were indications that one mill produced a longer top than did other mills included in the study and that there were differences between the mills in the amount of top yield.

(7) There was a good deal of variation in estimates made by the industry appraisal committee on the characteristics of noilage or wastiness, soundness, condition, and color and character; a need for more objective measurement of these characteristics was indicated.

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INTRODUCTION

Wool's physical and chemical properties determine its value and its use as a textile fiber. Its major physical characteristics include the fineness of the fiber, the length of the fiber, and the yield of clean fibers. Other factors relating to the commercial value of wool include crimp, strength, color, character, and elasticity.

Visual inspection and assessment of a lot of wool are the usual basis for preparation and sale. While considerable uniformity exists in the grading practices of the industry, the inherent difficulties of classification, and the fact that the operations are performed by various agencies, at different times, and under varying conditions, often lead to differences of opinion as to the accuracy of appraisals made by graders, handlers, and Government appraisers.

Within recent years, wool technologists have developed scientific means of measuring some of the more important physical properties of wool. They have devised laboratory tests for the determination of such factors as fineness, length, and yield on small quantities or samples of wool. These may be applied to commercial-size lots of wool through sampling, and their reliability in this connection is largely dependent on the samples selected being representative of the lot.

Until the present time, very little information was available on the adequacy of sampling and testing techniques. In an effort to obtain this and other information, an extensive study was undertaken on a number of lots of Government owned wool. Wools of various kinds, and varying in grade from fine to coarse, were processed through several stages of manufacture.

This report summarizes the data gathered from the sampling, testing, and processing of 46 lots of Commodity Credit Corporation wool. Its purpose is to determine (1) accuracy of visual appraisals for classifications and shrinkages and (2) a means of developing new wool standards which will facilitate determination of grade.

1/ Wool Laboratory, Standardization Branch, Denver, Colorado

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 40 cents

MATERIALS AND METHODS

Selection of wool.--In the selection of lots of wool for processing, such factors as size of lot, grade, staple length, type of combing, shrinkage, and geographical areas of production were considered. Selection was first made from CCC inventory records. The available lots were then examined by officials of the Agricultural Marketing Service or Commodity Stabilization Service before final selection was made. Wools stored in the Boston, Kansas City, Denver, and Portland areas were reviewed.

Forty-six lots acquired under price support programs during 1952 and 1953, comprising approximately 607,000 pounds of raw wool, were selected to be processed into wool top. Descriptions of these lots are given in table 1.

Many lot numbers are listed with the letters X or Y, such as lot 5195-X and lot 5195-Y. This signifies that the original lot 5195 has been divided into two lots of approximately equal size, these subdivisions being combed at different mills. Nine original lots were handled in this manner.

Industry appraisal committees.--Members of the trade in Boston, Portland, Oregon, and Denver were invited to appraise the selected lots visually and to give their opinions as to the various characteristics normally considered in determining the value of a lot of wool. The characteristics evaluated or estimated were grade, uniformity of grade, average length in inches for grease wool and top, soundness, color and character, condition, shrinkage, and noilage or wastiness.

The industry committee in the Boston area consisted of nine men. The Portland group was made up of four individuals, and the Denver committee of three.

Display bags representing 10 percent of the total number of bags in the lot were laid down for examination. All lots with the exception of two from the Kansas City area were examined by a committee.

Sampling for test purposes.--Bags or bales from each lot were selected at random and sampled to obtain grease wool staples for length determination and cores for yield and fineness determination.

The wool staple sampling tool was used to draw the staples from the bags laid down for coring. All staples were taken before coring.

Core sampling was done by USDA representatives using 1¼-inch, 3-inch, and 3/8-inch pressure coring tubes. The core sampling techniques were those regularly employed in connection with the wool price support program.

Weighing bags.--Bags were weighed immediately after each was core sampled, and their weights and the weights of all samples removed were recorded. All remaining bags in a lot were weighed at the completion of core sampling.

Table 1.--Lot number, CCC grade classification, origin, and clip year for 46 lots selected for processing

Lot number	C.C.C. grade classification	Origin	Clip year
5195X & Y	I-A1, Fine, 64s and finer	South Dakota	1952
5151	do	Utah	do
748X & Y	do	Wyoming	do
15637	I-A2, Fine, 64s and finer	Nevada	do
5222	do	South Dakota	do
KK2	do	Montana	do
2816	I-A3, Fine, 64s and finer	New Mexico	do
1042	do	Colorado	do
722½X & Y	I-B1, ½ blood, 60s and finer	Utah	do
P3B	do	Idaho	do
5074X & Y	do	Wyoming	do
4956	I-B2, ½ blood, 60s and finer	New Mexico	do
2205	do	Montana	do
5571	I-B3, ½ blood, 60s and finer	Montana	do
5432	do	South Dakota	do
4837X & Y	I-C1, 3/8 blood, 56/58s	Idaho	do
39045X & Y	IV-C1, 3/8 blood, 56/58s	South Dakota	do
58003X & Y	do	Minnesota	do
6	do	Missouri	do
1041	I-C1, 3/8 blood, 56/58s	Colorado	do
39151	IV-C1, 3/8 blood, 56/58s	N. Dak., S. Dak., Minn.	do
4023	do	Virginia	do
5034X & Y	I-D1, ¼ blood, 48/50s	Wyoming	do
255	do	Colorado	do
53265	do	Montana	do
29002X & Y	IV-D1, ¼ blood, 48/50s	Wisconsin	do
39338	do	Midwest area	do
52113	do	Illinois	do
55015	do	Kentucky	do
120D	I-D1, ¼ blood, 48/50s	Wash., Oreg., Idaho	1951
110E	I-E1, Low ¼ blood, 46s	do	do
210E	do	do	1952
16851	do	Idaho	do
2-200E	do	Valley Oregon	do
200E	do	do	do
2-200G	I-F1, Common and braid, 44, 40, 36s	do	do
100G	do	do	1951

The wools were then transported from the warehouse to the mills for processing.

Selection of combing mills.--A survey of combing mills was made through personal visits to plants having both French and Noble combs available for use. Details of the project were discussed with the mill management in each case. Particular attention was given to conditions under which the wool must be processed in order to furnish the research information desired by AMS and CSS. The final choice narrowed down to three mills. These mills are recognized in industry as quality processors and have the machinery and space needed to fulfill the objectives of the project. The three mills selected were the Abbot Worsted Company, Forge Village, Massachusetts; the Barre Wool Combing Company, Ltd., South Barre, Massachusetts; and the Hudson Worsted Company, Inc., Hudson, Massachusetts.

Preparation of wools for processing.--After a lot was weighed in at one of the mills and the bags were taken to the sorting room, the fleece strings were removed and the wools were put into bins to await the opening and scouring operations.

The fleeces were not sorted or skirted, but were processed in their original graded condition.

As the stringing progressed, handfuls of wool were drawn at intervals from all parts of the pile until a sample of between 5 and 10 pounds had been obtained. These samples are being held for reference purposes.

Processing.--The opening, scouring, carding and combing operational procedures normally used by the processor were followed.

Of the 46 lots processed, 26 were Noble combed, 11 were French combed, and 9 were split into approximately equal portions and one portion combed on Noble combs and the other on French combs at the same mill. At one mill the wools were split in the grease state into equal portions for the different combing operations. At the other mills the wools were divided at the card sliver state to be combed.

Weighing processed products.--All products and samples were weighed whenever possible. These products included scoured wool, card sliver or comb balls, top, noil, and all wastes.

Sampling of processed products.--Samples of mill products were taken for length, yield, and fineness determinations. Wherever possible, they were collected at regular intervals during processing. All samples to be used in determining yield were placed in air-tight containers.

Testing of samples.--All core samples of grease wool, with the exception of those drawn with the 3/8-inch pressure tube, were tested for yield by two commercial testing companies, the American Conditioning House, and the United States Testing Company, both of Boston, Massachusetts.

The 3/8-inch pressure core samples, the scoured wool, card sliver, samples of all wastes, top, and noil were analyzed for moisture, vegetable matter, ash, and extractives for clean yield purposes by the Livestock Division Wool Laboratory, Denver, Colorado. In addition this laboratory tested the grease wool staples and wool top for length and the core sample residues, card sliver, top, and noil for fineness.

YIELD

Wool as shorn from sheep contains varying amounts of natural grease, dried perspiration, dirt, and different kinds of vegetable matter. These extraneous substances are removed from the wool through "scouring." Their removal results in a considerable loss in the original weight of the wool. The loss, known in the trade as "shrinkage," may range as high as 78 percent and as low as 32 percent. The percentage of clean wool remaining is referred to as the "yield."

The impurities carried by grease wool greatly influence its market value. Because the actual amount of these impurities cannot be known until after scouring or processing, estimates of the shrinkage and yield are made through visual examination of the grease wool or through testing of samples extracted from bales or bags of wool by core-boring. A study of the use of core-boring for yield determination of imported baled grease wool was reported in 1941 (26) 1/. Since that time numerous articles on the coring of domestic wools have been published (7), (8), (9), (10), (13), and (24).

One of the objectives in this study was to find out how the use of various size coring tools and patterns affected the accuracy of yield determination and also to study the accuracy of yield estimates made by experienced wool men after visual examination. The clean yield results obtained from core tests and the estimates of the trade members are subsequently compared with actual mill yields.

Sampling and testing grease wool for clean yield determination.--The core-sampling patterns for each size tube are given in Figure 1. The sampling patterns, tools, and techniques used in this study were based on findings contained in publications (4), (12), and (23). The testing techniques followed closely the procedures outlined in (3) and (18).

For clean yield determination the 46 lots were sampled with coring tubes of various sizes. The tubes had cutting edge diameters of 3, 2, 1¼, and 3/8 inches. The 3-inch, 2-inch, and 1¼-inch tubes were powered by drill motors of either the standard 5/8-inch type or heavy-duty type, while the 3/8-inch tube was operated by manually thrusting the tool into the bags or bales. With either type the effect was to cut through a number of fleeces and produce a long core of wool. The 3-inch tube was used for the bagged lots, but it was necessary to substitute the 2-inch tube for the baled lots as the

1/ Underscored numbers in parentheses refer to Literature cited, page 65.

larger tube could not be forced into the bales. Wherever feasible each lot was sampled simultaneously with the tubes of all three cutting edge diameters. No end coring was done on the baled lots.

Coring schedule

Core	Bagged lots: Bags to core	Bagged lots: Cores per bag	Baled lots: Bales to core	Baled lots: Cores per bale
3/8-inch side	40	5	10	10
1¼-inch side	40	5	10	10
1¼-inch end	40	5	-	-
2-inch side	-	-	10	10
3-inch side	40	5	-	-

All core samples were analyzed for clean yield in a commercial testing laboratory with the exception of the 3/8-inch cores, which were tested by the Livestock Division Wool Laboratory. All clean yield results were calculated on the standard basis of clean wool containing 14 percent non-wool components.

Sampling and testing mill products for clean yield determination.--As each lot moved through the mill the products or semi-manufactures were sampled for clean yield determination. Where feasible the scoured wool, card sliver, top, noil, carding and combing wastes were sampled at regular intervals during processing. Otherwise they were sampled at time of weighing. All samples were placed immediately in double moisture-proof bags. Minimum samples obtained at random for each lot were:

Scoured wool - Random handfuls from all areas of the storage bins; total 10 pounds

Card sliver - Sections of sliver, each about 2 feet in length; total 5 pounds

Top - Sections of sliver, each about 2 feet in length; total 100 pieces

Noils - Random handfuls from bins or containers; total 2 pounds

Carding wastes - 1 pound

Combing wastes - 1 pound

All samples were tested for moisture, ash, vegetable matter, and grease content after which the weights were adjusted to the standard condition of 14 percent non-wool components (12 percent moisture, 1.5 percent extractables, and 0.5 percent ash). The testing procedure used was similar to that described in (6).

The adjustment factors thus determined were then applied to the actual weight of the product (card sliver, top, etc.) to arrive at an adjusted product weight. The adjusted product weight was then divided by the original weight of the lot of grease wool to calculate the clean yield percentage for the particular product. In subsequent tables of data there is reference to card sliver yield and top-noil-waste yield. The card sliver yield is calculated on the combined adjusted weights of the card sliver and carding wastes. The top-noil-waste yield is calculated on the combined adjusted weights of the top, noil, and all wastes.

Core Sampling Patterns

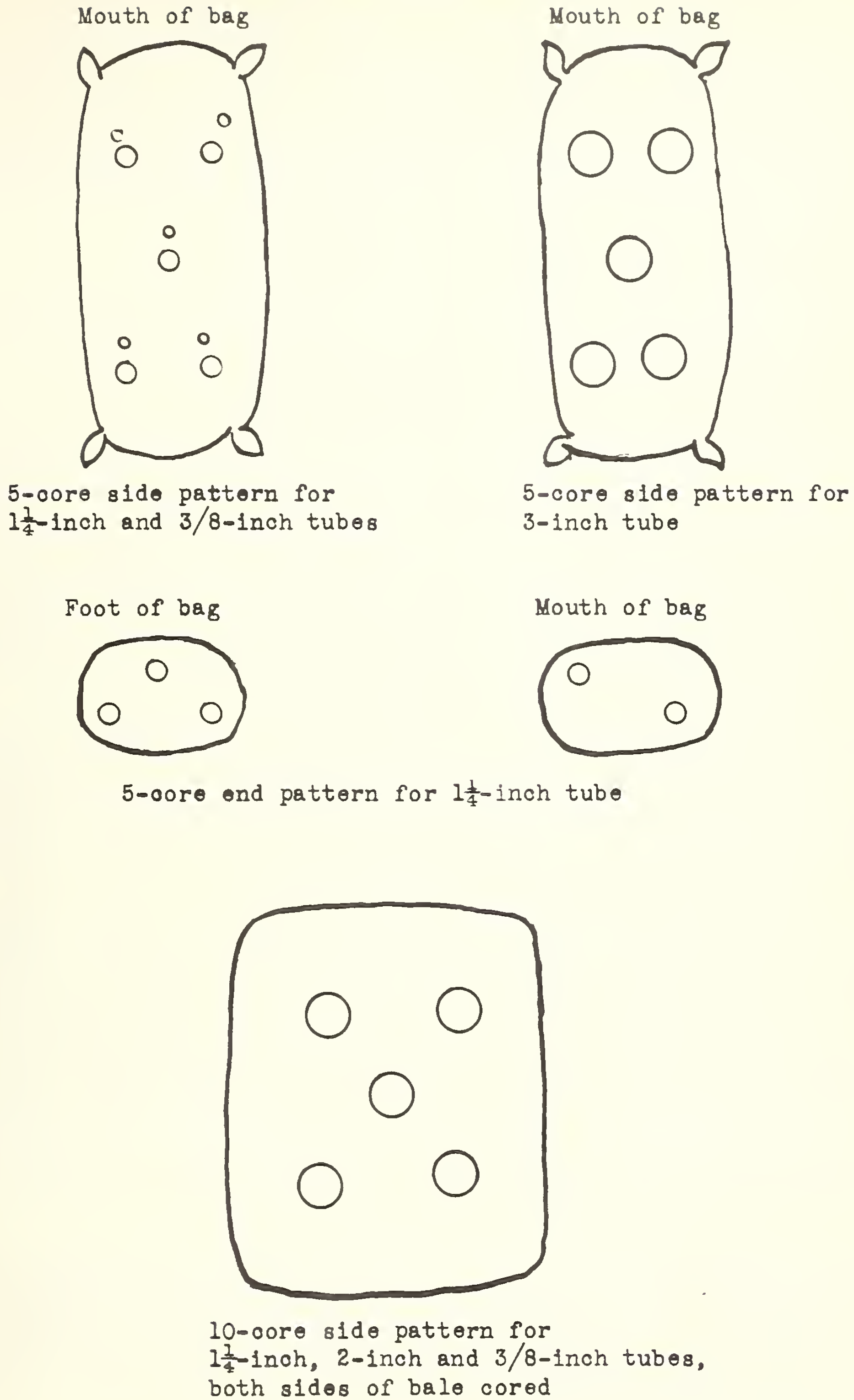


Figure 1.- Core-sampling patterns for 3/8-inch, 1¼-inch, 2-inch and 3-inch coring tubes.

The scoured yield is calculated on the adjusted weight of the scoured wool.

In subsequent data all weight and yield values have been adjusted to the standard condition of 14 percent impurities.

Comparison of mill yields and yields determined from core samples.--Table 2 presents the mill yields and the yields estimated from the cores taken from the various lots. Table 3 compares the averages of the mill yields and core yields as set forth in table 2.

Results indicate that clean yields determined from samples drawn with the 1¼-inch coring tube more nearly reflected the actual mill top-noil-waste yields than did yields made from samples obtained with the 3-inch or 3/8-inch coring tubes.

From the data in table 2 it can be seen that the range in differences in percent between the various core yields and top-noil-waste yields varies from lot to lot. In the over-all average for 41 lots, yields based on 1¼-inch side corings were found to be slightly over the mill top-noil-waste yield, and the yields based on 3-inch side corings were considerably over the mill top-noil-waste yield. The difference between the percentage of yield determined on the basis of 1¼-inch side core samples and the percentage top-noil-waste yield was 0.26. The difference was 1.86 when the same comparison was made using 3-inch core samples.

In 31 lots it was possible to compare yields based on the 3-inch side, 1¼-inch side, and 3/8-inch side cores. In this comparison, the average based on the 1¼-inch side core sample was a 44.75 percent yield, and the average yield percentage for top-noil-waste was 44.53. In contrast, the average yield based on the 3-inch side core sample was 46.55 percent, and based on the 3/8-inch side core sample it was 46.04 percent.

There were 26 cases where yields based on all four types of coring samples could be compared to the mill top-noil-waste yields. In these cases the average yields based on both the 3-inch side and 3/8-inch side core samples were heavier than the mill top-noil-waste figure, the differences in percent yield being 1.89 and 1.51 respectively. Less marked were the differences between the top-noil-waste average and the average based on the 1¼-inch core samples. Comparison of the yield percentages showed that yields based on the side core were slightly under and those based on the end core were slightly over the top-noil-waste figure, the differences in percent yield being 0.09 and 0.04, respectively.

These findings demonstrate that yields based on the 1¼-inch cores (side and end) more nearly predict the top-noil-waste yield of a lot of wool than do yields based on the other two types of cores (3-inch and 3/8-inch). As for the difference in the average estimates based on the 1¼-inch side and 1¼-inch end cores, this difference is so small that it appears to have no practical significance.

Table 2.--Mill yields and yields based on core samples for 41 lots of wool, by lot

CCC grade classification	Lot number	Mill yields - Percent			Yields on basis of core samples - Percent				
		Scoured	Card Sliver*	Top-noil-waste	1¼" Original	3" Side	1¼" Side	1¼" End	3/8" Side
Fine, 64's and finer	748X	29.06	30.07	28.98	30.60	29.72	29.76	28.36	30.10
	748Y	-	28.77	29.67	30.60	30.86	28.83	29.69	29.90
	5151	-	43.69	42.65	44.30	45.42	44.68	-	-
	5195-X	-	37.74	38.27	39.90	41.35	39.52	38.91	40.60
	5195-Y	-	38.13	38.53	39.90	38.89	37.53	36.96	39.50
	15637	-	37.27	37.92	37.10	37.38	36.74	35.81	38.60
	5222	-	31.91	32.13	31.40	34.53	31.66	33.59	33.40
	KK2	-	39.75	40.10	39.70	42.73	40.19	39.53	41.30
	2816	-	27.17	24.52	25.50	25.58	25.23	-	-
	1042	31.46	30.84	30.41	31.90	32.67	30.46	30.26	30.90
1/2 Blood, 60's and finer	722½-Y	45.02	45.20	44.32	46.40	47.02	43.49	44.95	46.50
	5074-X	41.21	1/39.31	38.89	39.80	42.50	40.20	39.46	41.30
	5074-Y	-	39.85	40.48	39.80	38.41	38.84	38.61	39.20
	4956	-	37.26	37.73	36.90	36.83	35.04	35.55	37.30
	2205	39.74	1/39.28	38.86	41.60	40.81	39.05	40.74	41.10
	5571	-	42.26	42.28	40.80	43.02	41.07	40.84	42.00
	5432	-	38.62	39.51	40.50	41.94	39.50	39.97	41.40
3/8 Blood,	4837-X	-	44.31	43.25	43.10	43.57	41.74	-	-
	4837-Y	-	43.33	43.26	43.10	46.62	42.86	44.26	44.20
	39045-Y	52.57	50.77	50.36	52.70	55.64	52.01	52.59	53.10
	58003-X	-	51.79	51.29	52.80	54.34	52.48	-	-
	58003-Y	-	52.64	51.91	52.80	53.61	52.24	51.22	55.30
	6	52.12	1/49.99	49.57	50.70	54.74	51.78	51.09	53.50
	1041	48.68	47.58	47.23	49.20	47.99	48.35	46.82	48.50
	39151	-	50.71	50.53	51.10	54.23	50.44	51.76	51.40
	4023	-	60.31	58.63	62.10	59.77	60.94	-	-
1/4 Blood, 48/50's	5034-X	-	42.25	41.84	40.30	42.91	41.69	-	-
	5034-Y	-	43.48	42.16	40.30	44.94	39.50	41.68	42.30
	255	47.06	45.93	44.61	49.00	47.04	45.66	45.92	48.50
	53265	-	49.13	48.77	49.00	49.06	48.16	48.89	48.50
	29002-Y	54.53	1/53.83	53.41	57.20	54.58	54.83	54.29	56.80
	39338	-	53.85	53.21	54.70	54.22	52.59	-	-
	52113	51.73	1/50.06	49.64	51.60	51.72	50.78	50.31	53.60
	55015	-	57.93	56.81	59.50	59.60	58.41	-	-
	120-D	55.72	1/53.01	52.59	52.20	2/56.13	54.12	-	54.50
Low 1/4 Blood, 46's	210-E	52.52	51.42	51.36	54.60	2/53.39	53.64	-	53.80
	16851	-	49.65	48.41	53.90	50.08	47.94	-	-
	2-200-E	63.76	62.01	61.87	64.30	2/69.14	65.66	-	64.30
	200-E	63.64	61.52	60.81	61.50	2/60.98	62.13	-	63.10
Common and braid, 44,40,36's	2-200-G	66.07	64.09	64.13	62.40	2/64.61	63.31	-	62.80
	100G	-	65.21	65.64	63.50	2/64.35	64.37	-	-

* Mill card sliver yields include the wool from the salable carding wastes.

1/ Card sliver weight was not available. Estimate was derived from the corresponding top-noil-waste yield by adding 0.42%, this value being the average difference between card sliver yield and top-noil-waste yield in 35 cases.

2/ Baled lot, cored with 2" tube

Table 3.--Comparison of average mill yields and average yields on basis of core samples for lots tabulated in table 2

CCC grade classification	Number of lots	Average mill yields Percent			Average yield based on core samples - Percent				
		Scoured	Card sliver	Top-noil-waste	1¼-inch original	3-inch side	1¼-inch side	1¼-inch end	3/8-inch side
Fine	2	30.26	30.45	29.20	31.25	31.22	30.11	29.31	30.50
	8	-	34.31	34.50	35.14	36.02	34.34	34.14	35.54
	10	-	34.53	34.28	35.09	35.89	34.45	-	-
1/2 Blood	3	42.99	41.26	40.69	42.60	43.44	40.91	41.72	42.97
	4	-	39.50	40.00	39.50	40.05	38.61	38.74	40.00
	7	-	40.25	40.30	40.83	41.50	39.60	40.02	41.26
3/8 Blood	3	51.12	49.45	49.05	50.87	52.79	50.71	50.17	51.70
	6	-	49.17	48.81	49.93	52.14	49.61	49.62	51.00
	9	-	50.16	49.56	50.84	52.28	50.32	-	-
1/4 Blood	4	52.26	50.71	50.06	52.50	52.37	51.35	-	-
	5	-	48.49	47.72	49.42	49.47	47.79	48.22	49.94
	9	-	49.94	49.23	50.42	51.13	49.53	-	-
Low 1/4	3	59.97	58.32	58.01	60.13	61.17	60.48	-	60.40
	1	-	49.65	48.41	53.90	51.20	48.50	-	-
	4	-	56.15	55.61	58.58	58.40	57.34	-	-
Common and braid	1	66.07	64.09	64.13	62.40	64.61	63.31	-	62.80
	1	-	65.21	65.64	63.30	64.90	65.20	-	-
	2	-	64.65	64.89	62.95	64.48	63.84	-	-
All grades	11	44.83	43.89	44.20	45.52	45.86	44.23	44.07	45.81
	16	49.68	48.43	48.56	49.73	50.54	49.09	-	50.15
	26	-	42.07	41.91	42.83	43.80	41.87	42.00	43.42
	31	-	44.70	44.53	45.44	46.55	44.75	-	46.04
	41	-	45.65	45.53	46.54	47.39	45.79	-	-

In table 2, under yields on basis of core samples, the column headed "1¼-inch Original" shows the yields based on 1¼-inch cores taken when the lots were accepted into the C.C.C. loan program in 1952-1953. It is interesting to note that the current yields based on 1¼-inch side core samples were less, on the average, than the original yields based on 1¼-inch side cores drawn 2 years previously. This difference in percent yield was 0.75 and was, no doubt, due to storage conditions, but nevertheless was surprisingly small.

Change of weights during storage.--For 39 lots complete storage weights were available and the following summary shows the average change, by grade, in the grease weights of the lots during the storage period.

CCC grade classification	Number of lots	Number of bags or bales	Net grease weight 1952-53	Net grease weight 1954	Difference 1954-(1952-53)
			Pounds	Pounds	Pounds
Fine	10	645	184,840	185,169	+329
1/2 Blood	9	494	123,959	124,757	+798
3/8 Blood	10	560	119,202	118,554	-648
1/4 Blood	7	359	78,228	77,133	-1095
Low ¼ Blood	3	88	36,058	36,987	+929
Total	39	2156	542,287	542,600	+313

Deviations of yields based on various size cores from top-noil-waste yields.--The previous discussion of yields based on core samples, as presented in table 2, was based on the average yield for the various size cores. Presented in tables 4, 5, 6, and 7 are the deviations in yields based on the various size cores (3-inch side, 1¼-inch side, 1¼-inch end, 3/8-inch side) from the top-noil-waste yields, by grade, for 41 lots of wool.

The results of these comparisons reveal that in relation to mill top-noil-waste yields the yields based on 3-inch core samples were definitely on the high side, and in 19 cases out of 41, or 46 percent, the deviations were outside a ±2.0 percent area. Deviations for the yield based on the 1¼-inch side cores were quite evenly distributed on the plus and minus side of 0, with 6 cases or 15 percent beyond a ±2.0 percent area.

Deviations for estimates based on 1¼-inch end cores had a reasonably even plus and minus distribution with only 3 cases or 12 percent outside a ±2.0 percent area.

Table 4.--Three-inch side core samples; percentage deviations between core yield and mill top-noil-waste yield (0); comparisons of 41 lots of CCC appraised wool

Deviation range	Lots, by grade						Total
	Fine	½ Blood	3/8 Blood	¼ Blood	Low ¼ Blood	Common and braid	
Percent	Number	Number	Number	Number	Number	Number	
7.1 to 8.0					1		1
6.1 to 7.0							
5.1 to 6.0			2				2
4.1 to 5.0							
3.1 to 4.0	1	1	2	1			5
2.1 to 3.0	4	2	1	3			10
1.1 to 2.0	1	1	2	2	2		8
0.1 to 1.0	3	2	2	3	1	1	12
0							
-.1 to -1.0	1						1
-1.1 to -2.0						1	1
-2.1 to -3.0		1					1
-3.1 to -4.0							
-4.1 to -5.0							
Total	10	7	9	9	4	2	41

Range of yield	Percent	Percent	Percent	Percent	Percent	Percent	Total
-2 to 2	50	43	44	56	75	50	54
-1 to 1	40	29	22	33	25	100	32

Table 5.--One and ½-inch side core samples: percentage deviations between core yield and mill top-noil-waste yield (0); comparisons of 41 lots of CCC appraised wool

Deviation range	Lots, by grade						Total
	Fine	½ Blood	3/8 Blood	¼ Blood	Low ¼ Blood	Common and braid	
Percent	Number	Number	Number	Number	Number	Number	
4.1 to 5.0							
3.1 to 4.0					1		1
2.1 to 3.0			2		1		3
1.1 to 2.0	2	1	3	4	1		11
0.1 to 1.0	4	1	1	1			7
0		1	1				2
-0.1 to 1.0	3	1	1	3	1	2	11
-1.1 to 2.0	1	2	1				4
-2.1 to 3.0		1		1			2
-3.1 to 4.0							
-4.1 to 5.0							
Total	10	7	9	9	4	2	41

Range of yield	Percent	Percent	Percent	Percent	Percent	Percent	Total
-2 to 2	100	86	78	89	50	100	85
-1 to 1	70	43	33	44	25	100	49

Table 6.--One and ¼-inch end core samples: percentage deviations between core yield and mill top-noil-waste yield (0); comparisons of 26 lots of CCC appraised wool

Deviation range	Lots, by grade						Total
	Fine	½ Blood	3/8 Blood	¼ Blood	Low ¼ Blood	Common and braid	
Percent	Number	Number	Number	Number	Number	Number	
4.1 to 5.0							
3.1 to 4.0							
2.1 to 3.0			1				1
1.1 to 2.0	1	1	2	1			5
0.1 to 1.0	2	3		3			8
0	1						1
-0.1 to 1.0	2		3	1			6
-1.1 to 2.0	1	2					3
-2.1 to 3.0	1	1					2
-3.1 to 4.0							
-4.1 to 5.0							
Total	8	7	6	5	0	0	26

Range of yield	Percent	Percent	Percent	Percent	Percent	Percent	Total
-2 to 2	88	86	83	100			88
-1 to 1	63	43	50	80			58

Table 7.--Three-eighths-inch side core samples; percentage deviations between core yield and mill top-noil-waste yield (0); comparisons of 31 lots of CCC appraised wool

Deviation range	Lots, by grade						Total
	Fine	½ Blood	3/8 Blood	¼ Blood	Low ¼ Blood	Common and braid	
Percent	Number	Number	Number	Number	Number	Number	
4.1 to 5.0							
3.1 to 4.0			2	3			5
2.1 to 3.0	1	3	1		3		8
1.1 to 2.0	3	1	1	1			6
0.1 to 1.0	4		2	1			7
0							
-0.1 to 1.0		2		1			3
-1.1 to 2.0		1				1	2
-2.1 to 3.0							
-3.1 to 4.0							
-4.1 to 5.0							
Total	8	7	6	6	3	1	31

Range of yield	Percent	Percent	Percent	Percent	Percent	Percent	Total
-2 to 2	88	57	50	50	0	100	58
-1 to 1	50	29	33	44	0	100	32

Yields based on 1¼-inch side and 1¼-inch end core samples seemed to parallel each other in both averages and deviations.

Yields based on the small 3/8-inch pressure cores showed the same pattern as those based on the 3-inch cores in both averages and deviations. The yields based on 3/8-inch core samples deviated largely on the plus side of 0 and in 13 cases or 42 percent were outside a ±2.0 percent area.

The comparisons have been presented using the mill top-noil-waste yield as a base in order to have as firm a foundation as possible for observing possible fluctuations in yield based on core samples. It is recognized that a mill scoured yield would lie approximately 1-1.5 percent away from the mill top-noil-waste yield, but in this study the difficulties of obtaining true scoured yields were also taken into consideration. It is extremely difficult to adequately sample scoured wool for clean yield analysis, especially for moisture content. The mills normally send the scoured wool directly from the dryers to carding in a very moist condition and even though the scoured wool may be put through a conditioning period prior to weighing in the scoured state, there has yet to be solved the problem of how to obtain representative samples for moisture tests without pursuing an impractical and expensive sampling schedule. At the start of the project the mills were asked to furnish either card sliver weights or scoured wool weights. Fortunately, at one mill it was possible to obtain both scoured weights and card sliver weights on 16 lots.

The comparison of averages in table 3 seems to indicate that top-noil-waste yields are not as low, compared to card sliver yields as formerly assumed. However, in considering scoured yields the uncertainties of moisture sampling of scoured wool are apparent. The differences in percent between the scoured wool yield averages and the comparable card sliver yield averages range from -0.19 to +1.98. While there is some loss through "fly" in the carding operations, this study does not indicate such loss would be in the neighborhood of 2 percent. The lots in this project produced 5,000 to 6,000 pounds of scoured wool and 2 percent of this amount would be 100 to 120 pounds of scoured wool. This amount of "fly" would literally bury a carding room.

The only logical answer to this mystery lies in discrepancies in the determination of moisture content of the scoured wool. Mill scoured yields need further study as to their stability, and sampling procedures must be developed to place these scoured yields on as firm a statistical basis as the card sliver and top-noil-waste yields. It is for these reasons that in the deviation tables an arbitrary ±2.0 percent was established as a basis of comparison. The sampling schedule followed was statistically designed to operate within ±1.0 percent of the true average 95 percent of the time, and assuming that the true scoured yield lies within 1-1.5 percent of the top-noil-waste yield; consequently it seemed reasonable to adopt a ±2.0 percent to evaluate the deviation data.

Yield estimates by industry appraisal committees.--As previously mentioned, an industry appraisal committee reviewed the lots prior to sampling and processing. These trade members placed an estimated yield percent on each lot in the routine manner followed in normal wool buying operations. The individual estimates of yield by the committee members and the yield estimates based on 1½-inch side core samples for corresponding lots are plotted in figure 2 and compared to the actual mill top-noil-waste yield. On the average, the yield estimates of experienced buyers, no doubt, come very close to accuracy, but frequently they are considerably over or under the actual clean yield of the lot in question. Core sampling, while not perfect, has improved the accuracy of clean yield estimation.

Figure 2 shows the visual estimations and yields based on 1½-inch side core samples for 39 lots of wool ranging from fine to braid. Shown on the chart are 239 visual estimates made by the committee, together with the yields based on 39 core samples. Neither the visual estimates nor the yields based on 1½-inch core samples exhibited any tendency toward an over or under bias. Of the 239 visual estimates, 119 were minus values and 120 were plus values, while the yields based on 1½-inch core samples show 18 lots on the plus side, 21 lots on the minus side,and 4 were practically perfect.

Fifty-four percent of the visual estimates were within ±2.0 percent of the top-noil-waste zero line, while 85 percent of the yields based on 1½-inch side core samples fell within this limit. The visual estimates deviated from +6.86 percent to -9.21 percent, while the yields based on the 1½-inch core samples deviated from +3.79 percent to -2.66 percent.

A comparison was also made using the scoured yields available as a base line (0). This comparison revealed that 50 percent of the visual estimates fell within ±2.0 percent of the scoured yields, while 93 percent of the yields based on 1½-inch side core samples were within a ±2.0 percent limit. The range for the visual estimates was from +5.26 to -7.72 percent. The yields based on 1½-inch core samples ranged from +1.90 percent to -2.76 percent from the scoured yields. Even though the scoured wool weights cannot be recorded as absolute, the comparisons here are interesting. These comparisons and results are similar to others reported in (19).

The visual estimate deviations from top-noil-waste yield were averaged by individual appraiser as were the deviations of yields based on 1½-inch side cores and 3-inch side cores. These values are shown in figure 3. At the bottom of the figure in the respective bars of the chart are shown the total number of estimates averaged (the top number), and then the number of estimate deviations on the plus side of zero (second number), and the number on the minus side (third number). These values are shown for each member of the industry appraisal committees. For example, Boston Appraiser Number 4 reviewed 32 lots and 50 percent (16) of his estimates were heavier than the mill top-noil-waste yields and 50 percent (16) were lighter. It also reveals that his estimates averaged 2.47 percent away from the top-noil-waste yields.

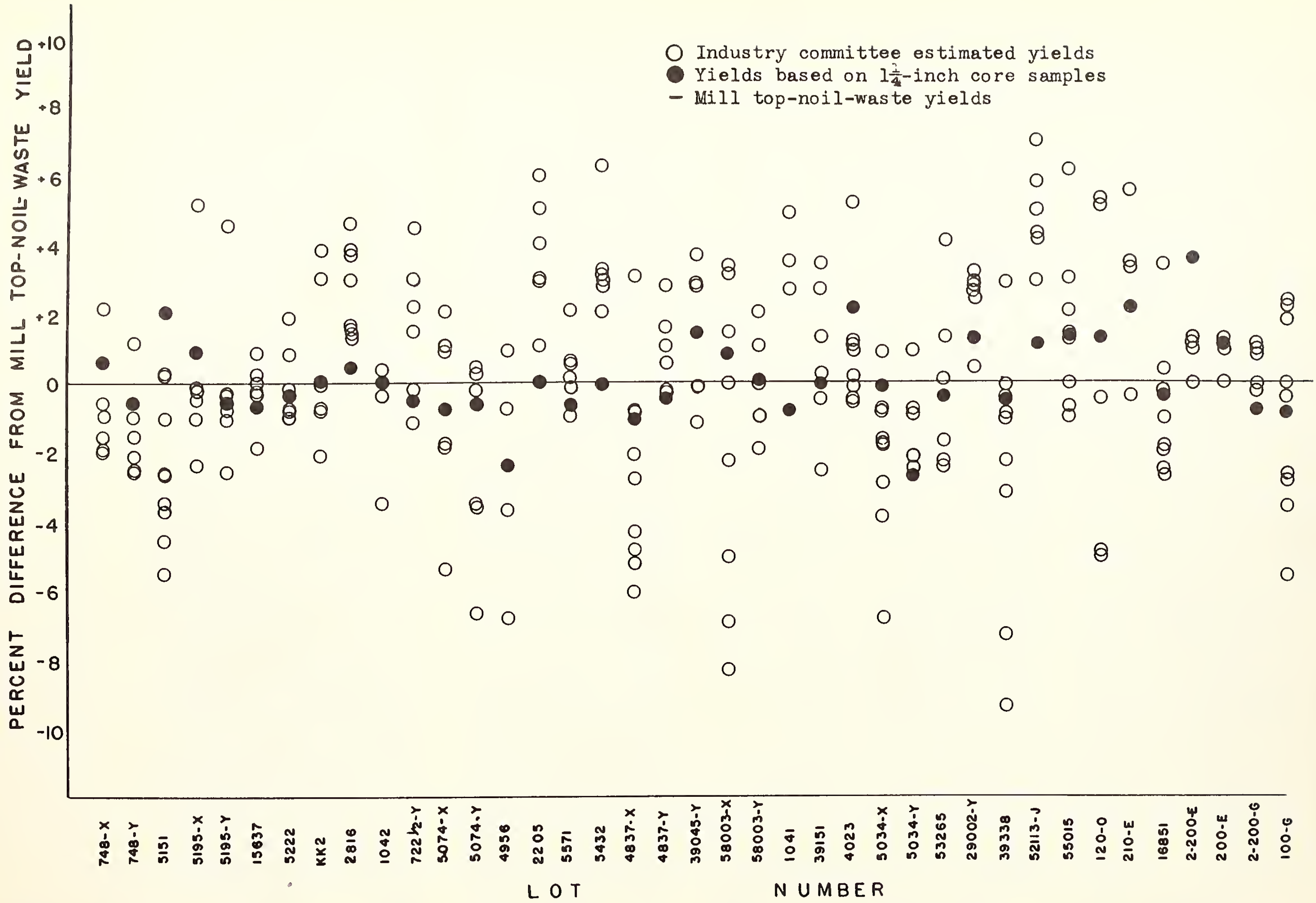


Figure 2.- Relationship of yields based on $1\frac{1}{4}$-inch side core samples and visual estimates of yield as compared to mill top-noil-waste yield (0).

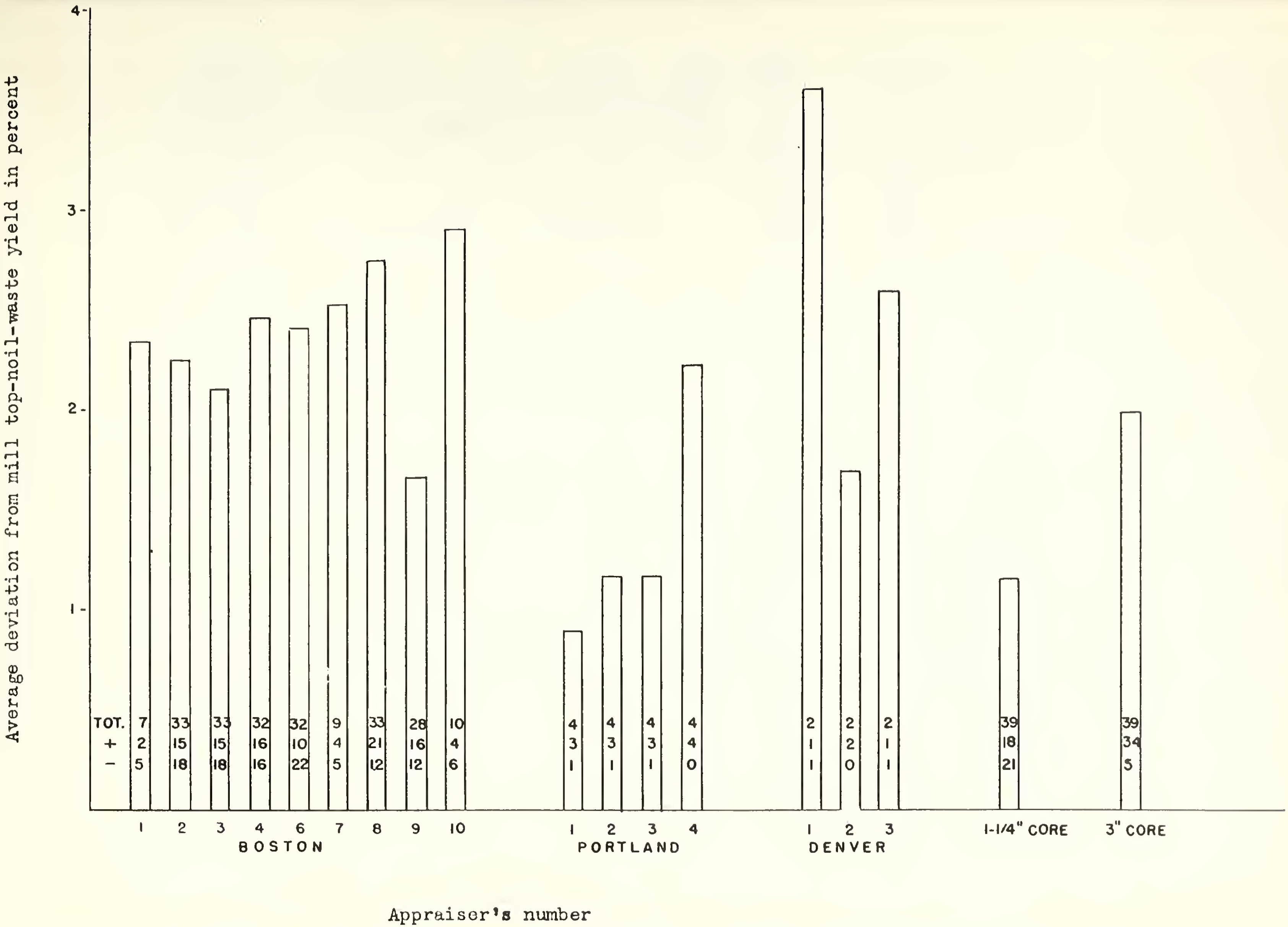


Figure 3.- Average deviation from mill top-noil-waste yield of appraisers estimates and yields based on core samples.

The Portland and Denver appraisers reviewed only 4 and 2 lots respectively, but the Boston appraisers looked at from 7 to 33 lots each. Boston Appraisers 6 and 8 had an apparent bias in their estimates but in opposite directions. Appraiser 6 tended to yield the wools too lightly while Appraiser 8 overyielded the same lots. The 1¼-inch side core was roughly 50-50 in its deviations and those deviations averaged 1.1 percent.

The 3-inch core showed a definite bias toward overyielding, 34 cases out of 39 being on the plus side and the average of these deviations was 2.0 percent.

The 3-inch core samples are quite large and it is reasonable to believe that laboratory subsampling and analysis is very difficult because of the necessity of handling these voluminous samples within the confines of a laboratory.

Top yield.--The previous discussions concerning yield were based on the total clean wool present at the various processing stages. However, it is necessary to consider the data in comparison with the amount of top produced from each lot.

The following tabulation shows the averages of percent noil on top and noil, top length, percent top, tear,aand top-noil-waste yield by grade of top produced:

Grade of top produced	Number of lots	Average percent noil on top and noil	Average length top (inches)	Average percent top	Average tear	Average top-noil-waste yield
64's	4	14.79	2.45	26.75	6.46	32.81
62's	10	11.84	2.68	29.32	7.85	34.74
60's	5	10.23	2.83	34.19	9.20	39.64
58's	10	10.18	3.05	37.42	9.16	43.76
56's	2	11.82	3.23	38.61	7.61	45.24
54's	9	10.67	3.26	42.11	9.35	48.82
50's	3	10.20	3.24	46.41	8.90	53.35
48's	4	11.36	3.77	43.91	8.30	50.50
46's	6	9.76	4.02	48.85	9.39	55.35
44's	1	8.89	4.76	58.01	10.25	58.01
40's	1	9.02	5.04	59.11	10.09	59.11

A wool that "noils" high and is wasty could easily be a high yielding lot for clean wool present, but yield a low percent of top. The top production efficiency of a lot can be measured by the "tear." This term indicates the ratio of the amount of top to the amount of noil. For example, if a lot produced 5605 pounds of top and 817 pounds of noil, 817 divided into 5605 equals 6.86 or the tear. This value, 6.86, is the number of pounds of top produced for every pound of noil combed out.

It can readily be seen that the higher the tear value the greater the financial return will be.

Some of the factors affecting the tear could be the length of the wool, soundness, and the degree to which the fibers have been weathered.

The lots producing a 48's top and 56's top were poor from a top-producing and noilage viewpoint.

Factors in the differences in top-producing efficiency are not only in the inherent characteristics and environmental conditions to which the wool has been subjected, but also the manner in which the wool was handled through the various mill processes.

Effect of different types of combing and different mills on top-noil-waste yield.--Inasmuch as three mills were used in the processing work and a number of lots were split between them it was possible to observe differences occurring in top-noil-waste yields and results of different types of combing. Table 8 shows comparisons of the top-noil-waste yields between mills and type of combing within mills for each lot.

The data reveal that mills 1 and 2 agreed very closely with each other and also that the type of combing within each of the two mills did not materially affect the top-noil-waste yield. The difference between Noble and French combing yield results on Lot 5195X in mill number 1 was only 0.23; and for its counterpart, 5195Y, in mill number 2 the difference was 0.21. A between-mill comparison on both types of combing is in very good agreement.

Mill number 3 did not agree with the other two, indicating that something varied in its processing. The greatest difference was between mill number 3 and mill number 1, with mill number 3 having an apparent tendency on the low yielding side in both Noble and French combing.

Mill number 3 and mill number 2 had only Noble combing comparisons, and here again mill number 3 tended to be low in yield.

The difference between the two types of combing within the same mill seems to be quite small. In one case (748-Y) the difference was 1.51 percent, but in the other 5 lots split within a mill the difference was less than 0.50 percent. Based on findings in this study it may be reasonably assumed that there is no top-noil-waste yield advantage for either type of combing within a mill.

The indication of between-mill differences in top-noil-waste yield is difficult to explain, but it is possible that certain mill practices vary to such a degree that these differences become magnified to a noticeable proportion.

Table 8.--Top-noil-waste yield percentages compared for the same lots, Noble or French combed at different mills

	Top-noil-waste yield					
	Mill No. 1		Mill No. 2		Mill No. 3	
	Noble combed	French combed	Noble combed	French combed	Noble combed	French combed
	Percent	Percent	Percent	Percent	Percent	Percent
748-X					29.15	28.81
748-Y	30.42	28.91				
722½-X	46.16	45.77				
722½-Y					43.99	44.65
5195-X	38.15	38.38				
5195-Y			38.63	38.42		
4837-X	43.25					
4837-Y			43.37			
58003-X			51.73			
58003-Y	51.91					
5034-X			41.84			
5034-Y	42.16					
5074-X					38.89	
5074-Y			40.97			
29002-X			54.19			
29002-Y					53.41	
39045-X			50.47			
39045-Y					50.36	

GRADE

The word grade when used in connection with wool refers to the quality of wool from the standpoint of fineness or fiber diameter.

There are two systems of grade terminology, the blood or American system and the numerical or count system. These two systems are used alternatively or interchangeably in the trade.

The blood or American system terms originally specified wool types grown on sheep with fractional quantities of Merino blood. Merino wool was called Fine. Other wools were grouped according to their relative degrees of coarseness as compared with the Merino. In the American system seven grades are generally used. They are Fine, Half Blood, Three-eighths Blood, Quarter Blood, Low-quarter Blood, Common, and Braid.

The wool grade terms "numerical" and "count" are alike or nearly alike in meaning. They are associated with yarn nomenclature and presumably originally designated the highest count of yarn into which the wool could be spun, the yarn count being the measure of the relative fineness or dimension of yarn. For example, a 64's grade of wool when processed and spun to capacity theoretically results in 64 hanks of yarn weighing, together, approximately 1 pound. A hank is 560 yards.

Both of these systems have lost their original significance, but the names associated with them are generally known and accepted as signifying various degrees of fineness in wool fiber. The numerical system is in general use in the international trading of wool, and it is believed that the fineness of wool can be designated more accurately by this system.

There have been official United States standards for grades of grease wool since 1923. These standards are represented by physical samples. The basis of these grade standards is fineness, or average fiber diameter, determined by visual inspection.

The official United States standards for wool top from the grade 80's through 50's have been defined on a micron basis since 1939. Similar specifications for the lower grades, 48's through 36's, and for the additional grade 54's, were added January 1, 1955.

The grade standards classify apparel wools on the basis of gradations of fineness. These gradations are extremely small. For example, the difference in average fiber diameter between the finest and coarsest of the fourteen grades of wool top is about 23 microns. One micron is approximately one twenty-five-thousandth of an inch.

It is the opinion of many connected with the wool trade that it is not practical to measure the fineness of fiber of grease wool by scientific methods, although this method is used for measuring the fineness in wool tops.

Therefore, in the past the grade of grease wool has been determined almost entirely by the sense of sight and touch, and as long as fleeces vary in grade and must be handled by human beings it will probably always be necessary to class wool by hand and eye.

While the present standards for grades of wool are good and have served a useful purpose, advances in wool technology have made it possible through scientific testing to define the grades more precisely and objectively. In view of this, on March 29, 1955, the Department proposed that the official wool standards now in effect be changed by providing specifications for fiber fineness and distribution for the 12 grades--80's through 36's, and that there be an addition of two new grades, a 62's and a 54's, with specifications for these two grades. These changes were based on extensive research studies that have been carried out in the past on many lots of wool.

One of the major aims of the grade portion of this study is to compare the accuracy of classifications made by appraisal and the accuracy of grade determined by sampling and testing grease wool, with actual grade of top produced by processing the raw commodity. Many other factors which may aid in the establishment and application of new wool standards were also investigated.

In order to accomplish these objective the grease wool of all 46 lots was processed into wool top. Samples of raw wool, card sliver, top, and noil were drawn as the lots were being processed. These samples were later measured for fineness and fiber distribution.

Sampling products for grade determination.--The importance of sampling cannot be over-emphasized because the accuracy of a test to determine fineness or grade depends largely upon whether or not the sample tested is representative of the entire lot. The sampling procedures used in this project are set forth for the various products as follows:

Grease wool.--It is essential that grease wool be scoured or otherwise cleaned before it is tested for fineness. In this study scoured wool resulting from testing core samples for clean yield was used to represent the lot. The core samples were those drawn from the side of bags or bales with the $1\frac{1}{4}$-inch tube.

In order to obtain test specimens of suitable size to be used for fineness determinations, the scoured core sample residues were divided into approximately 40 zones of equal size. From each zone at least 0.5 gram of wool was drawn at random. The composite of these 40 small draws was homogenized by carding on a small mechanical card. The resultant carded wool constituted the test specimen.

Card sliver.--Ten samples of card sliver, each approximately 6 feet long, were drawn at random intervals during carding. The intervals of sampling were so spaced as to get representation of the complete carding operation. Each sliver constituted a test specimen.

Top.--Five samples of top sliver, each approximately 12 feet long, were drawn after the ball of top was taken from the finisher. Care was taken to space sampling intervals at random so that samples taken would represent the lot. Each top sliver constituted a test specimen.

Noil.--Small amounts were collected periodically from the noil bins during combing, or randomly from the cumulations, until approximately 1 pound was secured for each lot. The sample was further reduced at the laboratory by dividing it into approximately 40 zones of equal size. At least 0.5 gram was drawn at random from each of the zones. The composite of these 40 one-half-gram tufts of noil constituted the test specimen.

Testing products for grade.--The technique used in this study for measuring fineness followed closely the USDA method of test for grades of wool top (21).

One test was made on each product. A test consisted of measurements by two operators of each test specimen drawn to represent the product. The number of test specimens measured per product were--grease wool and noil, 1 each; card sliver, 10; and top, 5. Each operator prepared one slide per test specimen.

The minimum number of fibers measured per test was that for the respective product and grade as prescribed in (1) and (21). Each operator measured one-half of the prescribed number.

From the observations recorded on the wedge scales the average diameter of fiber, fiber diameter dispersion, standard deviation, and coefficient of variation were calculated.

Interpretation of test results.--The official standards of the United States for grades of wool top were the basis for classification of top by grade (20).

The proposed standards for grades of grease wool, as published in the Federal Register of March 29, 1955, were the basis for classification of grease wool by grade (22). In this study the interpretation of these proposed standards differs from the interpretation of standards for wool top. In grading the grease wool on the basis of the tests on the core samples and card sliver samples, and in establishing the grade of the noil on the basis of tests, the following interpretations were made:

From the observed average fiber diameter and the fiber distribution of a sample, grade classification was made in accordance with proposed grease wool grade specifications issued in 1956 (1). The first step was to designate the grade within which the average fiber diameter fell, and the second step was to designate the finest grade to which the fiber distribution conformed.

For example, if the average fiber diameter fell within the average diameter range of a 64's and the finest grade to which the fiber distribution conformed was a 64's, the wool was classified as 64's. Here both average diameter and distribution meet the requirements for the same grade.

If the average fiber diameter fell within the average diameter range of a 64's and the finest grade to which the fiber distribution conformed was a 70's, the wool was classified as 64/70's. Here the split grade classification was used, the first term referring to the average diameter and the second to the fiber distribution.

If the average fiber diameter fell within the average diameter range of a 64's and the finest grade to which the fiber distribution conforms was a 62's grade, the wool was classified as a 64/62's.

Fiber diameter dispersion or distribution when used in connection with grease wool specifications refers to the percentage breakdown of fibers into convenient groups according to size or diameter. Specifications for this measure of the variability of fiber fineness are set forth in the standard grade or fineness requirements. The diameter of wool fibers can range from about 10 to 70 or more microns within the same bulk sample. When wool becomes highly variable in fineness it will not meet the dispersion values given in the standard grade specifications.

Accuracy of classifications made by visual appraisal.--In order to determine the accuracy of the classifications made by visual appraisal in connection with price support operations, two means of establishing accuracy were used. In the case of grade, one basis or "yardstick" for estimating accuracy was the grade of top produced; the other basis for comparison was the grade assessed by the industry trade committee.

The CCC appraisal grade classifications were made by Government appraisers who visually inspected the lots as they were submitted to the CCC for price support purposes.

The grades of top were determined by measurement and conformity with the official standards for grades of wool top.

The industry trade committee members evaluated the grade of the lots of grease wool according to the usual commercial practices.

The data in tables 9 and 10 show the CCC grade classification, the grade of top produced, and the deviation between the two. These comparisons are made by lot and type of combing.

The estimates for grade made by the trade members, the grade of top produced and the CCC grade classification are recorded in table 11.

It is evident from the data summarized in tables 9, 10, and 11 that the grade classifications made by visual appraisal on the 46 lots, in connection with price support operations during 1952 and 1953, were reasonably accurate.

Table 9.--C.C.C. grade classifications, the grades of top produced, by Fine and 1/2 Blood lots

Lot number	C.C.C. grade classification	Grade of top: produced 1/	Deviation of top grade from C.C.C. grade classification	Type of combing
5195X	I-A1, Fine, 64s and finer	62's	1 grade coarser	Noble
do	do	64's	Same grade	French
5195Y	do	62's	1 grade coarser	Noble
do	do	62's	1 grade coarser	French
5151	do	62's	1 grade coarser	Noble
748X	do	62's	1 grade coarser	Noble
do	do	62's	1 grade coarser	French
748Y	do	62's	1 grade coarser	Noble
do	do	62's	1 grade coarser	French
15637	I-A2, Fine, 64's and finer	64's	Same grade	French
5222	do	2/62's	1 grade coarser	French
KK2	do	2/62's	1 grade coarser	French
2816	I-A3, Fine, 64's and finer	64's	Same grade	French
1042	do	64's	Same grade	French
722½X	I-B1, ½ Blood, 60s and finer	58's	1 grade coarser	Noble
do	do	58's	1 grade coarser	French
722½Y	do	58's	1 grade coarser	Noble
do	do	3/58's	1 grade coarser	French
P3B	do	58's	1 grade coarser	Noble
5074X	do	60's	Same grade	Noble
5074Y	do	60's	Same grade	Noble
do	do	60's	Same grade	French
4956	I-B2, ½ Blood, 60s and finer	58's	1 grade coarser	French
2205	do	60's	Same grade	French
5571	I-B3, ½ Blood, 60s and finer	58's	1 grade coarser	French
5432	do	60's	Same grade	French

1/ Grade assessment is made by measurement. Unless otherwise noted the fineness or grade of the wool top specified conforms to the official standards of the United States for grades of wool top.

2/ Fiber diameter dispersion conforms to a 60's grade.

3/ Fiber diameter dispersion conforms to a 56's grade.

Table 10.--C.C.C. grade classifications, the grade of top produced, by 3/8 Blood, 1/4 Blood, low 1/4 Blood, common, and braid lots

Lot number	C.C.C. grade classification	Grade of top: Produced 1/	Deviation of top grade from C.C.C. grade classification	Type of combing
4837X	I-C1, 3/8 Blood, 56/58s	56's	Same grade	Noble
4837Y	do	58's	Same grade	Noble
do	do	58's	Same grade	French
39045X	IV-C1, 3/8 Blood, 56/58s	54's	1 grade coarser	Noble
39045Y	do	54's	1 grade coarser	Noble
58003X	do	54's	1 grade coarser	Noble
do	do	54's	1 grade coarser	French
58003Y	do	54's	1 grade coarser	Noble
6	do	54's	1 grade coarser	Noble
1041	I-C1, 3/8 Blood, 56/58s	56's	Same grade	Noble
39151	IV-C1, 3/8 Blood, 56/58s	54's	1 grade coarser	French
4023	do	50's	1 grade coarser	French
5034X	I-D1, 1/4 Blood, 48/50s	54's	Same grade	Noble
5034Y	do	54's	Same grade	Noble
255	do	50's	Same grade	Noble
53265	do	58's	1 grade finer	Noble
29002X	IV-D1, 1/4 Blood, 48/50s	46's	1 grade coarser	Noble
29002Y	do	46's	1 grade coarser	Noble
39338	do	46's	1 grade coarser	Noble
52113	do	48's	Same grade	Noble
55015	do	50's	Same grade	Noble
120D	I-D1, 1/4 Blood, 48/50s	48's	Same grade	Noble
110E	I-E1, Low 1/4 Blood, 46s	2/46's	Same grade	Noble
210E	do	48's	1 grade finer	Noble
16851	do	48's	1 grade finer	Noble
2-200E	do	46's	Same grade	Noble
200E	do	46's	Same grade	Noble
2-200G	I-F1, Common and braid 44,40,36s	44's	Same grade	Noble
100-G	do	40's	Same grade	Noble

1/ Grade assessment is made by measurement. Unless otherwise noted the fineness or grade of the wool top specified conforms to the official standards of the United States for grades of wool top.

2/ Fiber diameter dispersion conforms to 44's grade.

Table 11.--Grade estimates by trade members, grade of top produced, and C.C.C. grade classification

C.C.C. grade classification	Lot number	Grade of top produced	Number of trade members whose grade estimates fall into the following grade classifications: 64's and finer	60's and finer	56/58's	48/50's	46's	44/36's
Fine, 64's and finer	5195-X-Y	62's	5	1				
	5151	62's	9					
	748X-Y	62's	6					
	15637	64's	6					
	5222	62's	6					
	KK2	62's	6					
	2816	64's	9					
	1042	64's	3					
1/2 Blood, 60's and finer	722-1/2X-Y	58's		2	4			
	P3B	58's		5	1			
	5074X-Y	60's	1	5				
	4956	58's		4				
	2205	60's	3	3				
	5571	58's	3	3				
	5432	60's		5				
3/8 Blood, 56/58's	4837X	56's		5	4			
	4837Y	58's		1	5			
	39045X	54's			6	3		
	39045Y	54's			5			
	58003X	54's		2	7			
	58003Y	54's			5			
	1041	56's			2	1		
	39151	54's			6			
	4023	50's			9			
1/4 Blood, 48/50's	5034X	54's			5	4		
	5034Y	54's			1	4		
	53265	58's			5	1		
	29002X	46's				8	1	
	29002Y	46's				6		
	39338	46's			2	7		
	52113	48's			1	5		
	55015	50's			5	4		
	120-D	48's				6		
Low 1/4 Blood, 46's	110-E	46's				1	5	
	210-E	48's				2	2	
	16851	48's				7	2	
	2-200-E	46's					4	
	200-E	46's					4	
Common and braid, 44,40,36's	2-200G	44's						4
	100G	40's						9

Of the total of 46 lots of grease wool in this study graded for price support purposes, 22 produced a grade of top comparable to the wool grade placed on them; 21 of the lots produced a top which was coarser in grade than the original CCC appraisal; and 3 of the lots produced top which was finer than the appraised wool classification. In comparing the grade of grease wool and that of the top produced and in interpreting the accuracy of the CCC grade classifications, it should be borne in mind that these visual appraisals were made by non-technical methods and on the basis of wool standards under which no physical grade measurements were specified.

The visual assessments for grade made by Government appraisers and those made by industry members compare very closely. Seventy-eight and five-tenths of the grade estimates were in agreement. Seventeen and two-tenths percent of the visual grade estimates made by the trade members were finer grades and 4.3 percent were coarser grades than the CCC grade classifications.

Of the total of 256 estimates for grade made by the trade members, 44.9 percent compared to the grade of top produced, 52.7 percent were finer, and 2.4 percent coarser.

It should be noted here that the wools processed into top were in their original graded condition. It is not known whether or not, if these wools had been skirted, the fineness would have been altered sufficiently to make the top grade correspond to the visual grade estimates. Undoubtedly there are certain instances in which this might have taken place. However, only four of the 46 lots failed to meet the maximum fiber distribution requirements of the standards for grades of wool top; therefore, the percentage of coarse fibers could not have been very high.

Application of new grease wool standards for determining grade.--The 1-1/4 inch side core and card sliver samples were tested for fineness. To facilitate the determination of grade the proposed standard specifications for grades of raw wool were applied to the test results. The grades of the raw wool of each lot thus assessed are presented for comparison with the grades of top produced and the CCC grade classifications in tables 12 and 13.

Judging by the data developed in this study, the use of measurement techniques and the application of the new proposed standards and specifications for grades of grease wool appear to have great promise for assessing grade.

From the data of tables 12 and 13 it can be seen that grades based on laboratory measurement of raw wool samples are more consistent with the grade of top produced than the visual estimates of grade. For example, these data show that the grade of raw wool determined by the measurement of the 1-1/4 inch core samples classifies 42 of the 46 lots as the same grade as the grade of top produced. For 2 of the lots the estimated grade of raw wool was one grade finer than the grade of top produced; and for 2 of the lots the estimated grade of the raw wool was coarser. The subjective classification made by CCC appraisers matches the grade of top produced for 22 of the 46 lots.

Table 12.--Grades of raw wool as determined by testing 1-1/4-inch side core and card sliver samples, grades of top produced, and C.C.C. grade classifications, by fine and 1/2-Blood lots

C.C.C. grade classification	Lot number	Grade of raw wool determined by testing the following: 1/ 1-1/4-inch side core	Card sliver	Grade of top produced 2/	Type of combing
Fine,	5195X	62/64s	62/64s	62's	Noble
64s	do		62/64s	64's	French
and	5195Y	62s	62/64s	62's	Noble
finer	do		62s	62's	French
	5151	64s	62/64s	62's	Noble
	748X	60/62s	62/64s	62's	Noble
	do		62/64s	62's	French
	748Y	62s	62s	62's	Noble
	do		62s	62's	French
	15637	64s	64s	64's	French
	5222	62/60s	62s	3/62's	French
	KK2	62s	62s	3/62's	French
	2816	64s	64s	64's	French
	1042	62/64s	64s	64's	French
1/2-Blood,	722-1/2X	58s	58s	58's	Noble
60s	do		58s	58's	French
and	722-1/2Y	58s	58s	58's	Noble
finer	do		58s	4/58's	French
	P3B	58s	60s	58's	Noble
	5074X	60s	60s	60's	Noble
	5074Y	60s	60s	60's	Noble
	do		60s	60's	French
	4956	58/60s	58s	58's	French
	2205	60/58s	60s	60's	French
	5571	58s	58s	58's	French
	5432	58s	60s	60's	French

1/ Basis: proposed standards for grades of wool
2/ Grade assessment is made by measurement. Unlessotherwise noted the fineness or grade of the wool top specified conforms to the official standards of the United States for grades of wool top.
3/ Fiber diameter dispersion conforms to a 60's grade.
4/ Fiber diameter dispersion conforms to a 56's grade.

Table 13.--Grades of raw wool as determined by testing 1-1/4-inch side core and card sliver samples, grades of top produced and C.C.C. grade classifications, by 3/8-Blood, 1/4-Blood, low 1/4 and common and braid lots

C.C.C. grade classification	Lot number	Grade of raw wool determined by testing the following: 1/ 1-1/4-inch side core	Card sliver	Grade of top produced 2/	Type of combing
3/8 blood, 56/58s	4837X	58s	58s	56's	Noble
	4837Y	56/58s	58s	58's	Noble
	do		58s	58's	French
	39045X	54s	54s	54's	Noble
	39045Y	50/54s	54s	54's	Noble
	58003X	50s	54s	54's	Noble
	do		54s	54's	French
	58003Y	54s	54s	54's	Noble
	6	54/56s	56s	54's	Noble
	1041	56s	56s	56's	Noble
	39151	54s	54s	54's	French
	4023	50s	50s	50's	French
1/4 blood, 48/50s	5034X	54/50s	50s	54's	Noble
	5034Y	54s	54/50s	54's	Noble
	255	50/54s	54s	50's	Noble
	53265	58s	58s	58's	Noble
	29002X	46s	46s	46's	Noble
	29002Y	46/48s	46s	46's	Noble
	39338	48s	48/46s	46's	Noble
	52113	48s	50/48s	48's	Noble
	55015	50s	48s	50's	Noble
	120D	48s	48s	48's	Noble
Low 1/4 blood 46s	110E	46s	46s	3/ 46's	Noble
	210E	48s	48s	48's	Noble
	16851	50s	48s	48's	Noble
	2-200E	46s	46s	46's	Noble
	200E	46/48s	46s	46's	Noble
Common and braid, 44/40/36	2-200G	44s	44s	44's	Noble
	100-G	40s	40/44s	40's	Noble

1/ Basis: proposed standards for grades of wool
2/ Grade assessment is made by measurement. Unless otherwise noted the fineness or grade of the wool top specified conforms to the official standards of the United States for grades of wool top.
3/ Fiber diameter dispersion conforms to a 44s grade.

The grades of the raw wool determined from the core and card sliver for each lot were compared. The general grade classification made on the basis of the core sample was the same as that determined from the card sliver sample for 41 of the 46 lots. The classification made from the core sample was one grade finer than that of the card sliver for one lot, and one grade coarser than the card sliver for four lots.

The grade of the raw wool determined from testing the card sliver sample was the same as the grade of top produced for 43 of the 46 lots. For those that differ, the grade was one grade finer than the grade of top produced.

The relationship between the fineness of wool top, raw wool, and noil.--The changes taking place in fineness when raw wool is processed into wool top are presented diagrammatically in figure 4. These changes follow very closely the pattern observed in other work (14), (16), (17), and (25). The top is coarser than the product from which it is combed. This difference has been attributed primarily to the removal of noils during combing. The spread in fineness between top and raw wool increases with coarser wools. There appears to be very little difference between the fineness of grease wool and card sliver. The noil is finer than either the top from which it is combed or the product being combed.

The effect of different types of combing on fineness.--In figure 5, results of testing for fineness are presented for nine lots of wool that were divided and combed on Noble and French combs within the same mill. These wools were combed in this manner to observe the effect, if any, of the two different types of combing on the fineness of top produced.

Analysis shows that there was no apparent effect on the fineness of top produced by different types of combing. The difference in fineness that existed between the Noble-combed top and the French-combed top from the same lot was small and within the range expected to arise due to chance. Actually the average difference in fineness between the tops produced from these two combing systems was approximately 0.21 micron, with the largest difference being 0.46 micron and the smallest 0.12 micron.

The effect on fineness of combing at different mills.--Nine of the original lots were split into lots of approximately equal size. The halves were combed at different mills. The purpose was to study the influence of combing by different mills on the fineness of the top produced. The results of testing these lots for fineness are given in figure 6.

This figure shows that, for wools of the same original lot, combing at separate mills caused little difference in the fineness of the top produced. The average difference was approximately 0.20 micron, with a range of from 0.71 micron to zero difference.

After establishing that, on the basis of the data studied, there is no important mill influence on fineness, it is interesting to note the consistency of the average fineness of the products of the split lots. These data

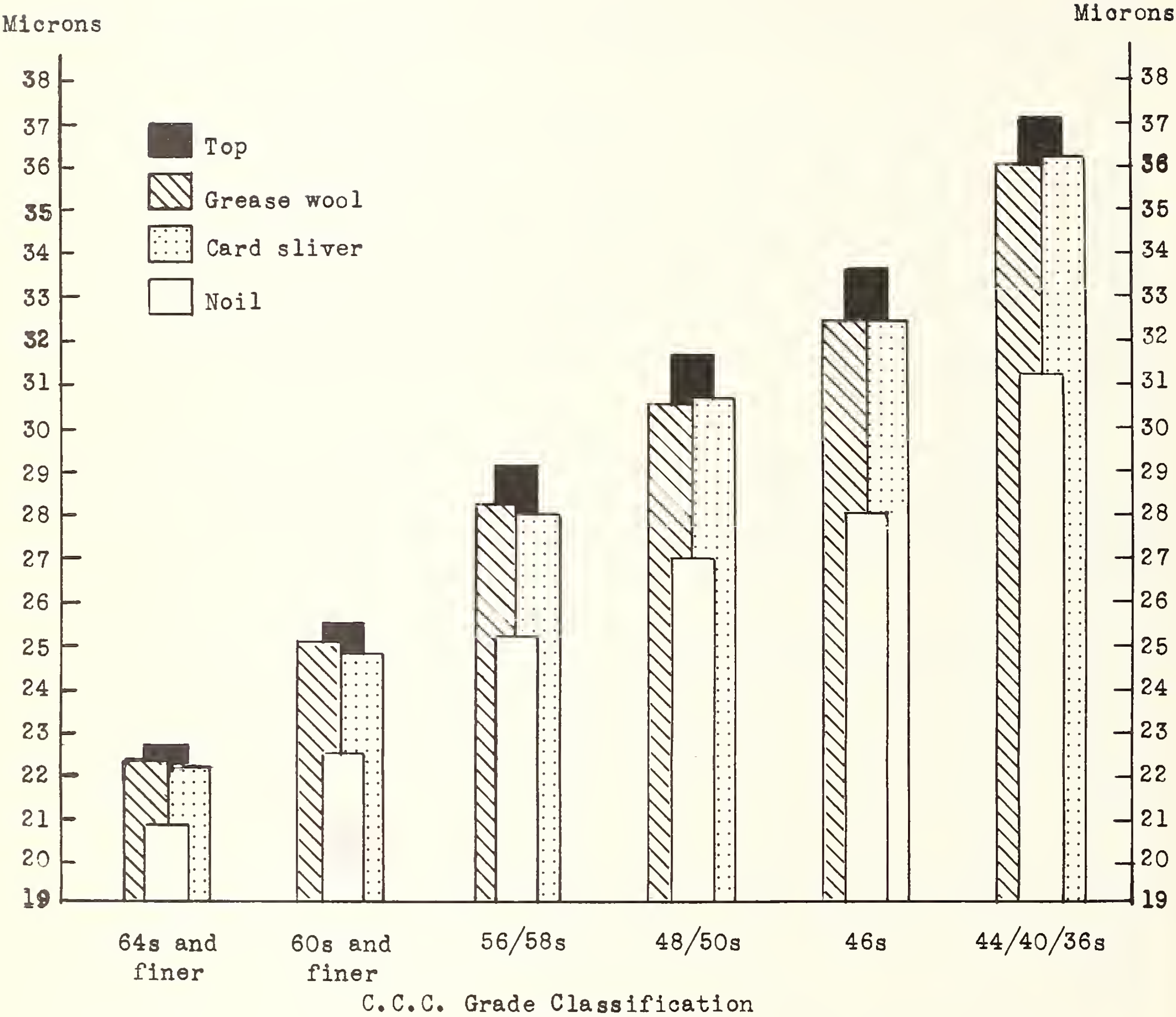


Figure 4.- Average fineness of top, grease wool, card sliver, and noil by CCC grade classification.

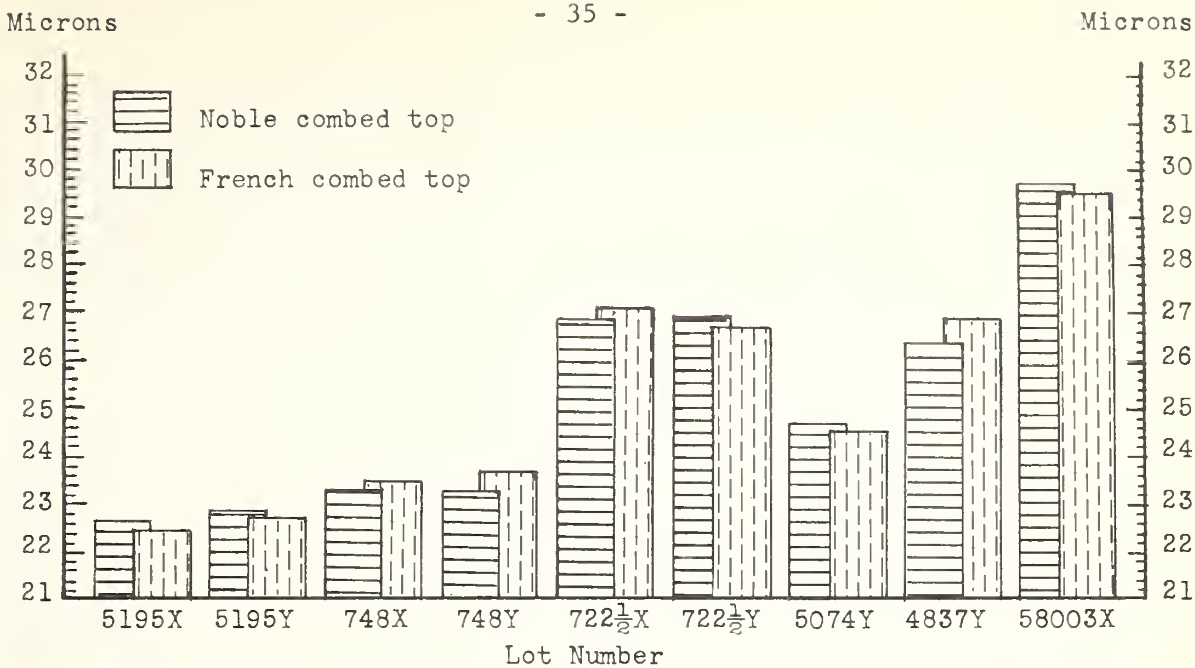


Figure 5.- The effect of Noble and French combing on the fineness of wool tops produced from the same original lot.

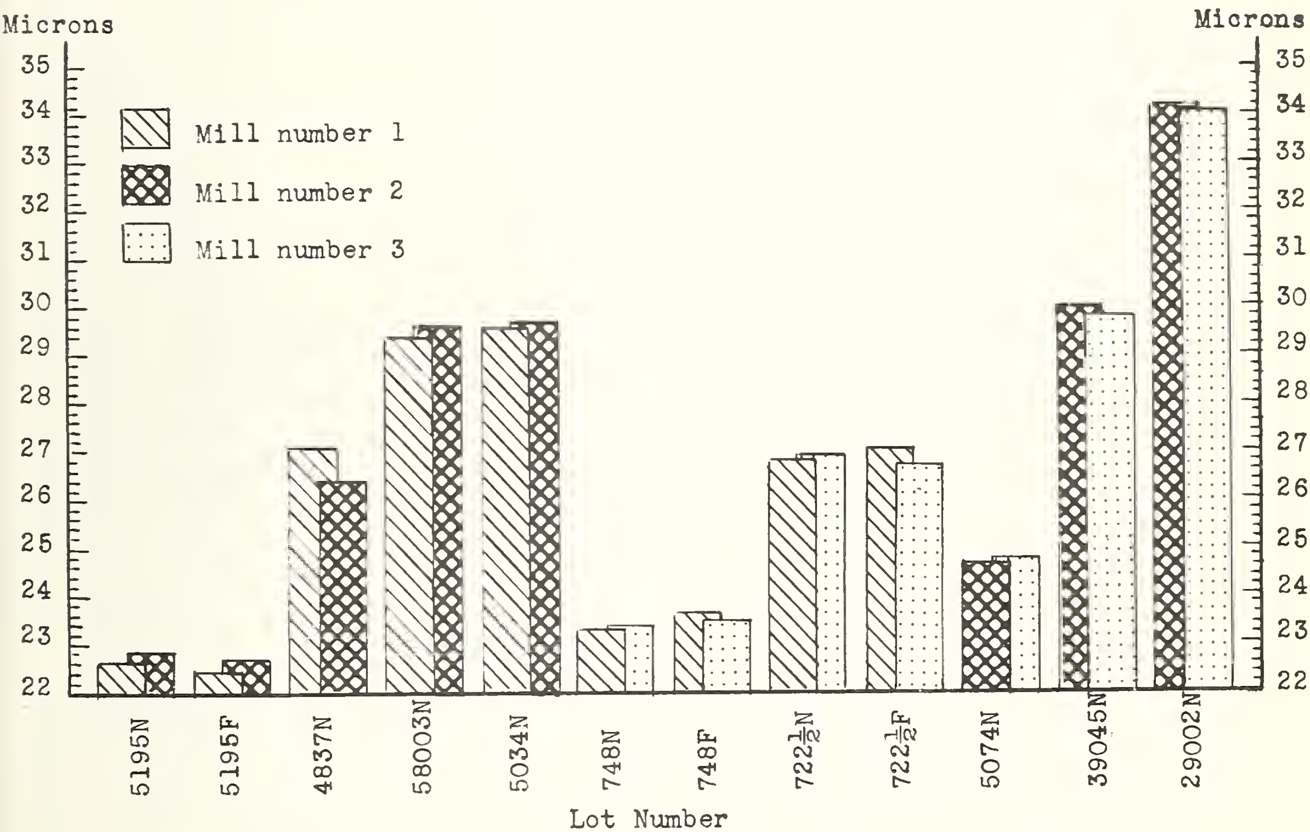


Figure 6.- The fineness of tops from the same original lot, (N) Noble or (F) French combed at different mills.

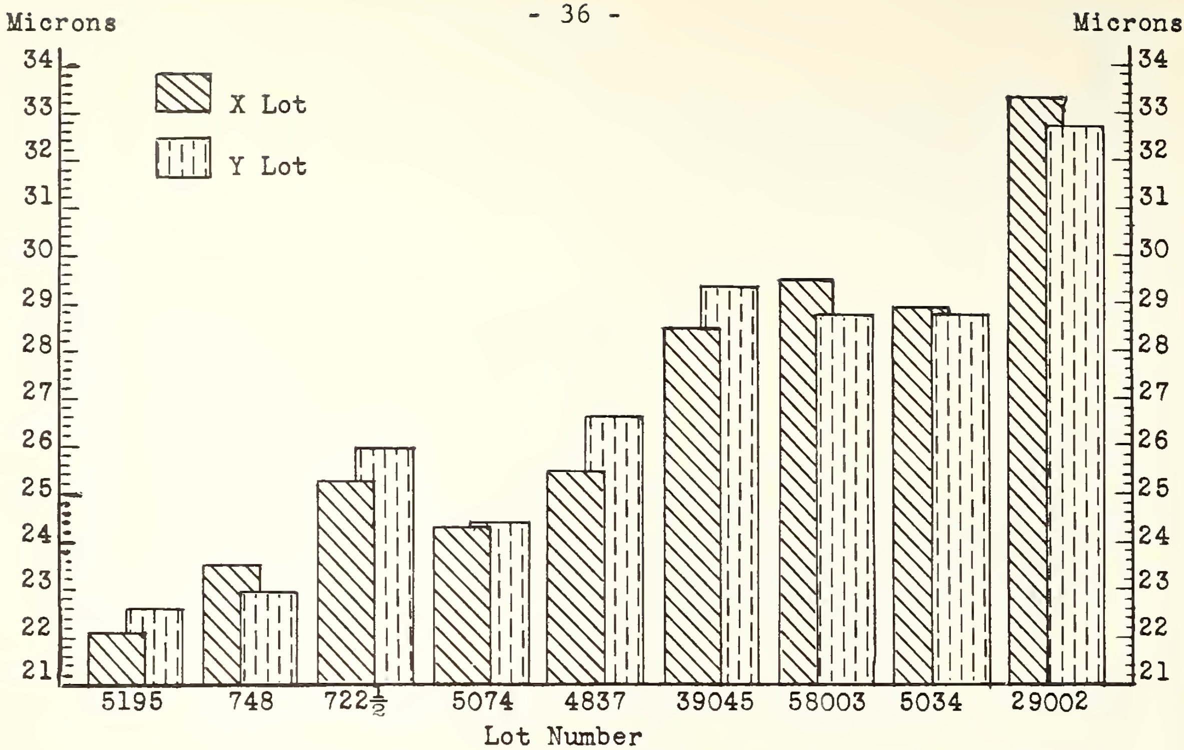


Figure7.- The fineness of $1\frac{1}{4}$-inch core samples drawn from the split (X and Y) lots.

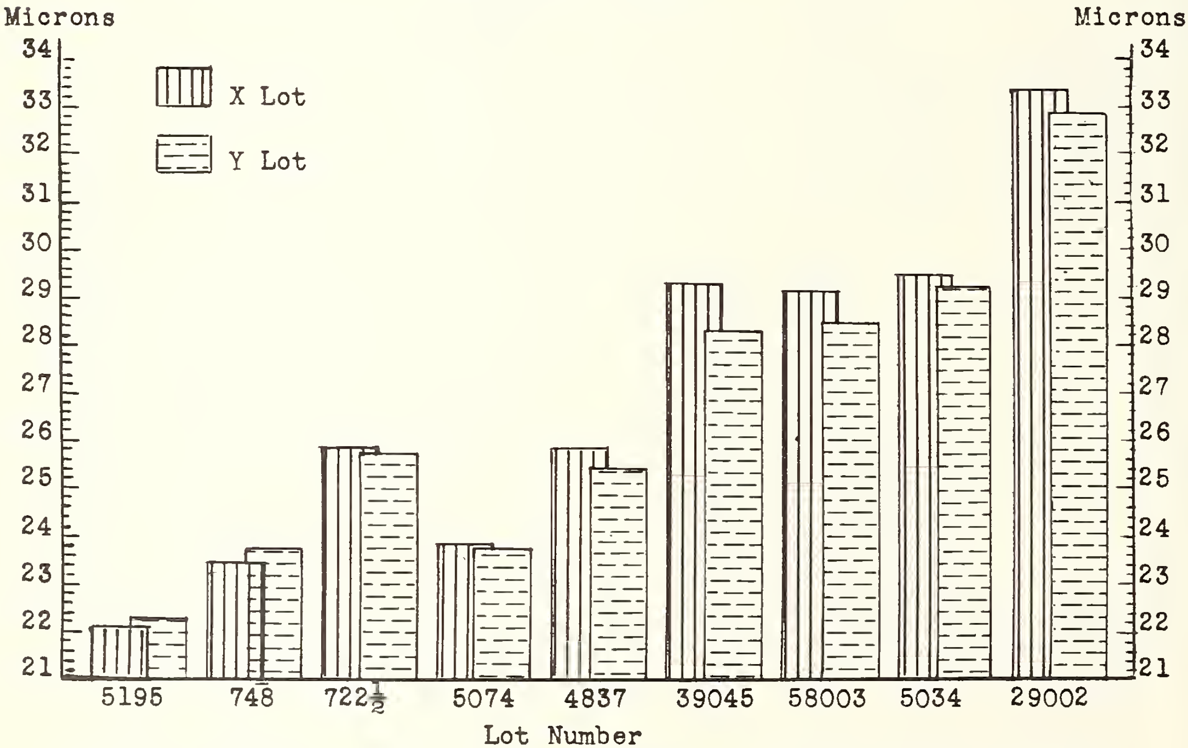


Figure 8.- The fineness of card sliver samples drawn from the split (X and Y) lots.

are reproduced in figures 5, 6, 7, and 8. This consistency reflects very good testing and sampling techniques, especially for the top. Among the data resulting from testing top, card sliver, and core samples for fineness, that for the core samples exhibited the greatest variance between split lots; however, this variance was not too great. The average difference in fineness shown in tests on top, card sliver, and core samples was approximately 0.2 micron, 0.4 micron, and 0.6 micron, respectively.

LENGTH

Length is one of the more important physical properties of the wool fiber. It is very significant from the standpoint of utility and value. It is a basis for the classification and description of wool, whether marketed as grease wool or wool top.

There are no official length standards for domestic wools; however, staple length classes based on objective measurement have been suggested for grades of grease wool (15).

To describe length, such terms as staple, good French combing, average French combing, short French combing, clothing, and stubby are used in wool trading. These terms mean that within a grade, staple wools are the longest, good French combing comes next, then average French combing, etc. Generally, longer wools of the same grade are worth more than shorter wools. It is recognized that these length terms do not indicate precise lengths, nor in the prectice of trading do they stand for the same lengths in the various grades.

For these reasons, and since staple length varies within a fleece, and from fleece to fleece within a graded lot, it is felt in the trade that it is impossible exactly to classify wool for length. However, methods of testing have been developed which will give very reliable estimates of the average staple length and range in staple lengths within a graded lot (5) and (11).

While there are no official standards for length in grades of wool top, certain top makers have private length standards, for some grades, upon which they make negotiations. Contract valuation requirements of the Wool Associates of the New York Cotton Exchange, Inc., are based on various length classes, with objective specifications, within a grade. A method for determining the average fiber length and distribution of fiber lengths of top has been used in the industry for some time. (2).

The purpose of this report is to compare the length of objectively drawn and measured grease wool staples and the length of top produced from this grease wool with the length appraisal classification. The studies reported here were made to obtain data for the possible development of length standards and to investigate the accuracy and feasibility of sampling and testing grease wool for length.

Sampling products for length determination.--Grease wool.--Staples of grease wool were obtained from the bags laid down for coring. Twenty bags per lot were sampled and 6 staples were drawn from each bag. All staples were taken before coring.

The wool staple sampling tool illustrated in figure 12 was used to draw the staples from the bags. By thrusting the point of the tool into a bag or bale and withdrawing it by a direct pull with a slight turn, a person drawing a sample gets a small quantity of wool in the hook as the tool is withdrawn. Three staples were drawn from one edge of the bags and 3 from the opposite edge. The depth that the tool was inserted into the bag was so gauged that three different levels of the interior were reached. Staples obtained in this manner were measured for length.

Top.--The top samples used for length determination consisted of 2 slivers drawn at random from the 5 samples of top sliver which had been drawn for fineness determination.

Testing products for length determination.--The measurement techniques used for determining grease wool staple length and fiber length of wool tops were similar to those described in publications (2), (5), and (11).

The principle of the method used for measuring the normal grease wool staple length consists first of preparing staples to a uniform size of approximately 0.25 inch in diameter, then, without stretching or elongating the staple, simply using a ruler to measure its length. This length is measured to the nearest 1/4 inch. After the normal length is measured, the stretched length is measured by stretching the staple to a point where further tension would seem likely to break the fibers. The stretched length is also measured to the nearest 1/4 inch.

The method for estimating the fiber length of wool top employs a wool fiber stapling apparatus (Suter). This machine segregates the fibers within a sliver of top into 1/2-inch length intervals. The fibers within these interval groupings can be collected and weighed to determine the average fiber length and distribution of fiber lengths.

All length measurements in this study were performed by two operators, one measuring the odd numbered grease wool staples and the odd numbered top samples. The second operator measured the even numbered staples and the even numbered top samples. The measurement results of the two operators were combined.

The average length, standard deviation, and coefficient of variation were calculated for each lot on the basis of the data on normal grease wool staple length, stretched staple length, and fiber length of wool top.

C.C.C. length classifications.--In appraising wool for price support purposes, Government appraisers visually inspected the wool for grade and at the same time classed it for length. In order to check the length

appraisal classifications, the wools in this project were measured to determine the normal and stretched grease wool staple lengths and the fiber length of wool top produced. These measurement results along with the C.C.C. length classifications are tabulated for each lot in tables 14 and 15.

The data in these tables reveal that the appraisal length classifications were substantially accurate.

For the lots classified as grade 64's and finer, and 60's and finer, the measurement results show that in most cases there are reasonable divisions between the length classes within a grade. Also, with the exception of two lots classified as 60's and finer, average and good French combing, the difference in average normal staple length between lots within a single appraisal length class did not exceed 0.26 inch.

Since there was only one appraised length class for the lots of the grades 56/58's and coarser, no length comparisons could be made in these grades. However, the range in average normal staple length between the lots within the single length class was much greater for these coarser and longer wools than it was for the wools in the finer grades.

Comparison between the average length of normal staples, average length of stretched staples, and average fiber length of wool top.--It will be seen from the data in tables 14 and 15 that the average normal or unstretched staple length of grease wool is a better indicator of the average fiber length of wool top than is the average stretched staple length.

The length measurement studies on the 39 lots classified as grades 64's and finer, 60's and finer, 56/58's, and 48/50's indicate that the average length of normal grease wool staple and the average length of wool top fibers were, in general, similar. In some instances the top length was longer than the normal grease wool staple length and vice versa. The data reveal that the procedure used to measure the stretched staple length in this study always resulted in a length considerably longer than either the normal staple length or the average fiber length of top. For the 46's and 44,40,36's wools, the difference between the normal staple length and average fiber length of wool top is greater. In 6 of the 7 lots tested, the length of the top is much shorter than the average normal staple length.

Length estimates by trade members.--The industry committee members estimated the average length in inches for the grease wool. Some of the committee members specified their estimates for the length of grease wool as being either on a normal (unstretched) or stretched basis; however, these were few in number and the basis of most of the length estimates was not designated as to normal or stretched length.

A summary of the length estimates in relation to average length of stretched staples, average length of normal staples, and average fiber length when combed into top is given in table 16.

Table 14.--C.C.C. length classification by grade, stretched and normal wool staple length, and average fiber length of top produced for fine and 1/2 blood lots

C.C.C. grade classification	C.C.C. length classification	Lot number	Average length of: Stretched staple	Average length of: Normal staple	Average fiber length of top	Type of combing
			Inches	Inches	Inches	
Fine, 64's and finer	Strictly staple	5195X	3.59	2.88	2.90	Noble
					2.91	French
	do	5195Y	3.59	2.87	2.91	Noble
					2.85	French
	do	5151	3.71	2.95	2.47	Noble
	Staple and good French combing	748X	3.14	2.55	2.57	Noble
					2.59	French
	do	748Y	3.04	2.48	2.74	Noble
					2.81	French
	do	15637	3.26	2.52	2.60	French
	do	5222	3.26	2.62	2.53	French
	do	KK2	2.98	2.36	2.41	French
	Short French cobbing, clothing and stubby	2816	3.04	2.28	2.21	French
		1042	2.69	2.06	2.09	French
1/2 blood, 60's and finer	Staple and good French combing	722-1/2X	3.52	2.85	3.11	Noble
					2.99	French
	do	722-1/2Y	3.67	2.96	2.87	Noble
					2.80	French
	do	P3B	3.93	3.10	3.22	Noble
	do	5074X	3.62	2.96	3.07	Noble
	do	5074Y	3.71	2.97	3.01	Noble
					2.89	French
	Average and good French combing	4956	3.52	2.79	2.90	French
		2205	2.96	2.36	2.43	French
	Short French combing and clothing	5571	3.03	2.40	2.64	French
		5432	3.16	2.47	2.73	French

Table 15.--C.C.C. length classification by grade, stretched and normal wool staple length, and average fiber length of top produced for 3/8 blood, 1/4 blood, low 1/4 blood, and common and braid

C.C.C. grade classification	C.C.C. length classification	Lot number	Average length of Stretched staple	Average length of Normal staple	Average fiber length of top	Type of combing
			Inches	Inches	Inches	
3/8 blood, 56/58's	Staple and good French combing	4837X	4.31	3.37	3.41	Noble
		4837Y	4.13	3.28	3.17	Noble
	do	4837Y			3.11	French
	do	39045X	4.13	3.26	3.19	Noble
	do	39045Y	3.97	3.20	2.90	Noble
	do	58003X	3.91	3.15	3.36	Noble
	do	58003X			3.21	French
	do	58003Y	3.97	3.14	3.53	Noble
	do	6	3.64	2.91	2.87	Noble
	do	1041	4.23	3.45	3.05	Noble
	do	39151	3.02	2.40	2.64	French
	do	4023	3.86	2.86	2.87	French
1/4 blood, 48/50's	Staple and good French combing	5034X	4.49	3.66	3.71	Noble
		5034Y	4.41	3.62	3.89	Noble
	do	255	4.55	3.75	3.32	Noble
	do	53265	4.35	3.57	3.69	Noble
	do	29002X	5.06	4.10	3.95	Noble
	do	29002Y	4.73	3.98	3.41	Noble
	do	39338	4.73	3.86	3.87	Noble
	do	52113	4.40	3.57	2.97	Noble
	do	55015	4.30	3.33	3.54	Noble
	do	120D	5.15	4.38	3.99	Noble
Low 1/4 blood, 46's	Staple and good French combing	110E	5.82	5.09	4.47	Noble
		210E	5.87	5.05	4.11	Noble
	do	16851	4.86	3.91	3.99	Noble
	do	2-200E	6.10	5.23	4.25	Noble
	do	200E	6.44	5.53	4.17	Noble
Common and braid, 44,40,36's	Staple and good French combing	2-200G	6.95	6.12	4.76	Noble
		100G	7.14	6.21	5.04	Noble

One of the most significant points brought out by the data in table 16 is that the length of grease wool estimated by the trade committee members compares more closely with the actual average length of normal staples than do the estimates for stretched staple length with the actual average length of stretched staples. There was no marked tendency for the estimated length to be longer or shorter than the actual normal staple length. However, approximately 89 percent of the estimates were shorter than the stretched staple length measurements reported in this study. Also 67.1 percent of the length estimates were within ± 0.50 inch of the measured length of normal staples compared to 30.4 percent for the stretched length.

From the data in table 16 it is observed that the estimates for the average length of the wool top were inclined to be longer than the actual fiber length of the tops. Sixty-five and six-tenths percent of the estimates of the fiber length of top came within the limits of ± 0.50 inch of the average fiber length of the top produced, and 87.8 percent of the estimates came within the limits of ± 1.0 inch.

The precision of the trade committee members in estimating the lengths of the grease wool and the length of the wool top produced from these wools was greater for the finer grades than it was for the wools of the coarser grades.

The effect on length of different types of combing.--Figure 9 presents results of tests for length for the 9 lots of wool that were divided and combed on Noble and French combs within the same mill. The top length and the average normal staple length data are included in this figure.

Studies of the test data on the 9 lots suggest that the Noble combing produced a slightly longer top than did the French combing. The differences that did exist were small. The average fiber lengths of the Noble-combed tops were slightly longer than the French-combed tops in 6 of the 9 lots, ranging from 0.07 to 0.15 inch longer. For the 3 lots in which the Noble-combed tops were shorter than the French-combed tops the differences ranged from 0.01 to 0.07 inch.

Figure 9 also shows the lengths of the tops in direct comparison with the normal lengths of the grease wool from which they were made. The mean difference was 0.12 inch and the smallest and largest differences observed were 0.02 nnd 0.33 inch respectively.

The effect on length of combing at different mills.--In order to determine how combing by different mills influences the length of top produced, nine of the original lots were split into lots of approximately equal size and the halves were combed at different mills.

Figure 10 diagrammatically presents the results of tests for length of top for these lots. These data suggest that the fiber length of the top produced from the nine lots was affected by combing at different mills. There was a consistent tendency for mill number 1 to produce a longer-fibered

Table 16.--Summary of length estimates made by trade members in relation to actual length measurements

Length deviation range	Deviation of length estimates from measurements for the following: Average length of stretched staple	Average length of normal staple	Average length when combed into top
Inches	Percent	Percent	Percent
+2.01 and over	-	-	3.5
+1.01 to 2.00, incl.	-	5.2	8.1
+0.51 to 1.00, incl.	2.4	15.5	18.7
+0.26 to 0.50, incl.	0.9	12.2	14.1
+0.05 to 0.25, incl.	6.1	16.4	22.2
0	1.4	8.0	9.6
-0.05 to 0.25, incl	7.5	16.9	12.6
-0.26 to 0.50, incl.	14.5	13.6	7.1
-0.51 to 1.00, incl.	41.8	5.6	3.5
-1.01 to 2.00, incl.	20.7	5.2	0.6
-2.01 and over	4.7	1.4	-
Total ±0.25 of zero deviation	15.0	41.3	44.4
Total ±0.50 of zero deviation	30.4	67.1	65.6
Total ±1.00 of zero deviation	74.6	88.2	87.8
Total ±2.00 of zero deviation	95.3	98.6	96.5
Total zero deviation	1.4	8.0	9.6
Total greater than zero deviation	9.4	49.3	66.6
Total less than zero deviation	89.2	42.7	23.8

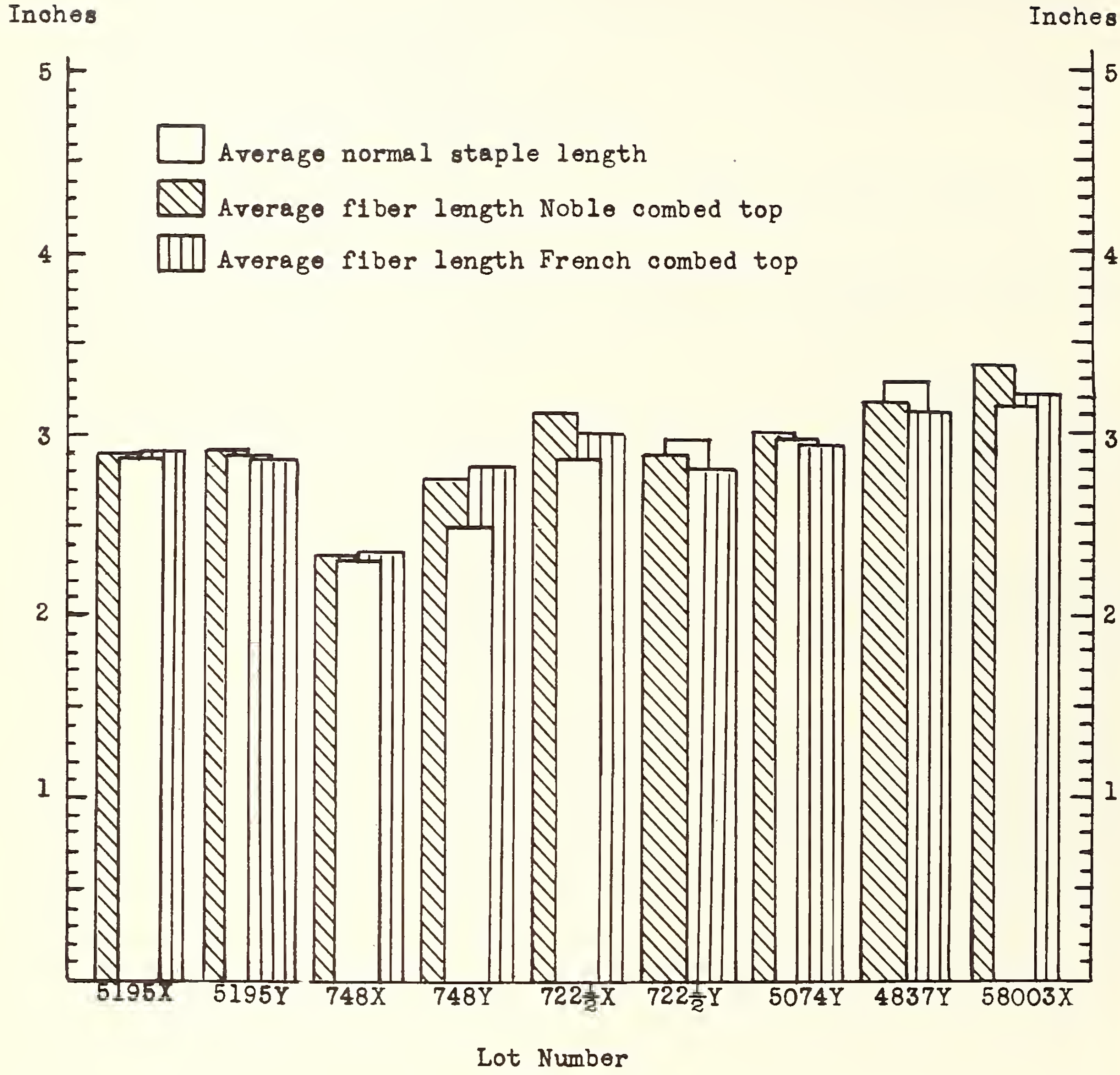


Figure 9.- Effect on length of Noble and French Combing, comparing length of top produced from wools of same original lot.

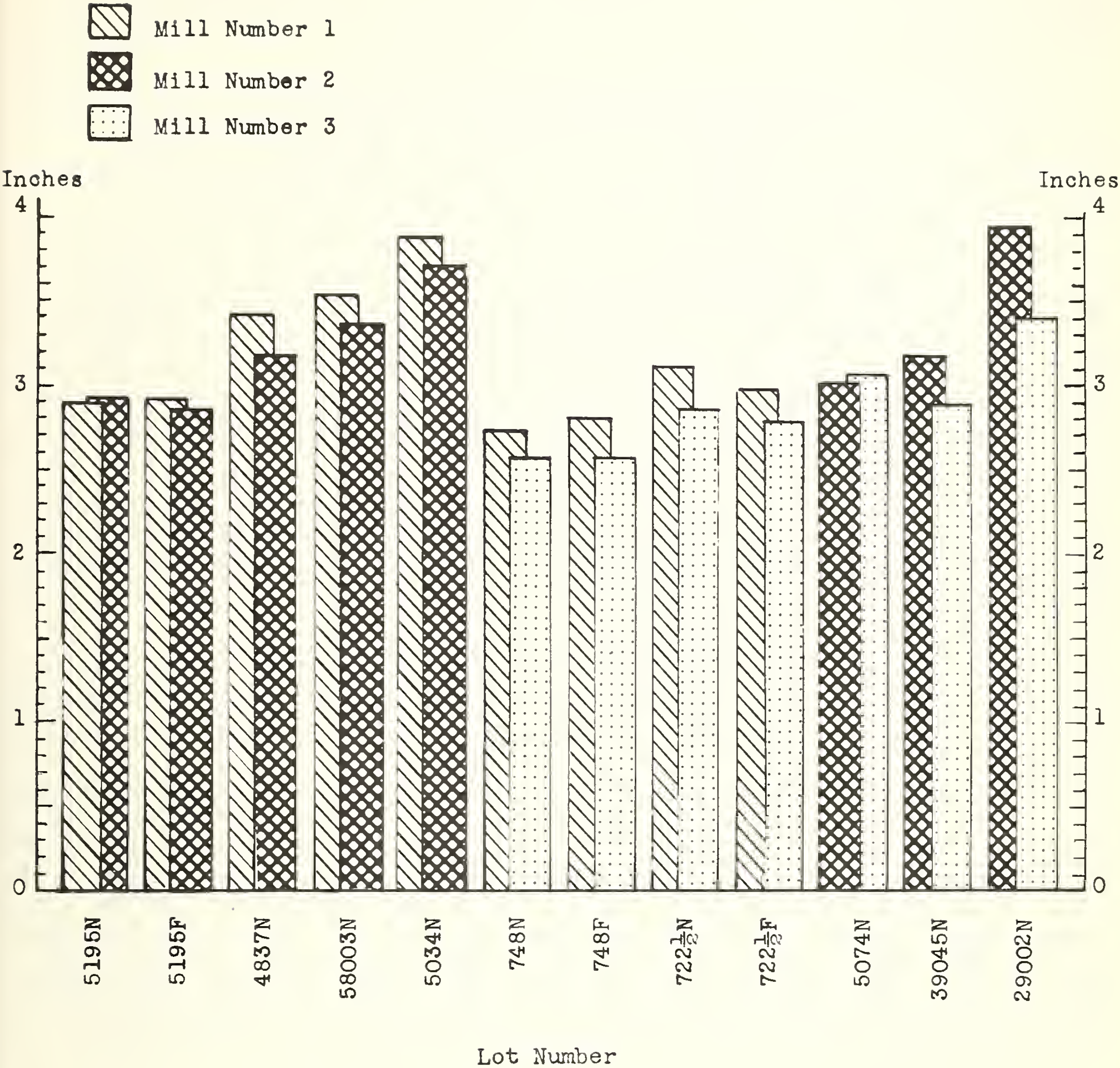


Figure 10.- Effect on length of Noble and French combing at different mills, comparing length of top produced from wools of same original lot.

top than either mill number 2 or mill number 3. The mean difference in fiber lengths of the tops produced was approximately 0.2 inch and the differences ranged from 0.01 inch to 0.54 inch. It can be seen from figure 11 that the lengths of the grease wools making up these split lots did differ slightly but not nearly as much as the length of top combed from these wools. It appears, therefore, that the differences observed in top length must be accounted for by processing.

Application of tests for determining length of grease wool.--The data of this study indicate that estimates of the average staple lengths and range in staple lengths within a graded lot can be made with reasonable accuracy. Furthermore, these data indicate that the length of grease wool can be used to estimate the length of the top that will be combed from the wool.

The accuracy or consistency of testing for length can be observed in figure 11. The length measurements depicted in this figure are the normal staple lengths of grease wool drawn from split lots of the same original lot. The mean difference between the average normal staple lengths of the split X and Y lots was only 0.06 inch, the smallest difference was 0.01 inch, and the largest 0.12 inch. These differences are small and within the range expected to arise due to chance. According to the "t" test the difference in staple length of duplicate lots was not significant.

From 20 of the lots of wool in bags, individual staples were drawn with the wool staple sampling tool and individually marked. Six staples per bag were drawn from 20 bags per lot. Samples were drawn according to the diagram shown in figure 12.

Analysis of the measurements of the normal staple length of the samples obtained as shown in figure 12 indicated that the differences in length between the staples drawn from the one or the other side of the bags, or from the mouth, the middle or the butt of the bag were not statistically significant.

The staple length data were further analyzed to obtain standard deviation values. The analyses of variance data of the 10 lots of the grades 64's and finer, and 60's and finer were combined and the mean standard length deviation value for between-bags was calculated to be 0.11 inch and for within-bag, 0.48 inch. For the 10 lots of wool of the grades 56/58's and coarser the mean standard length deviation value for between-bags was 0.15 inch and for within-bags 0.67 inch. In practice this indicates that more staples should be drawn per bag and more bags in a lot sampled for the coarser and longer wools than for the finer wools if the same precision of results is to be attained.

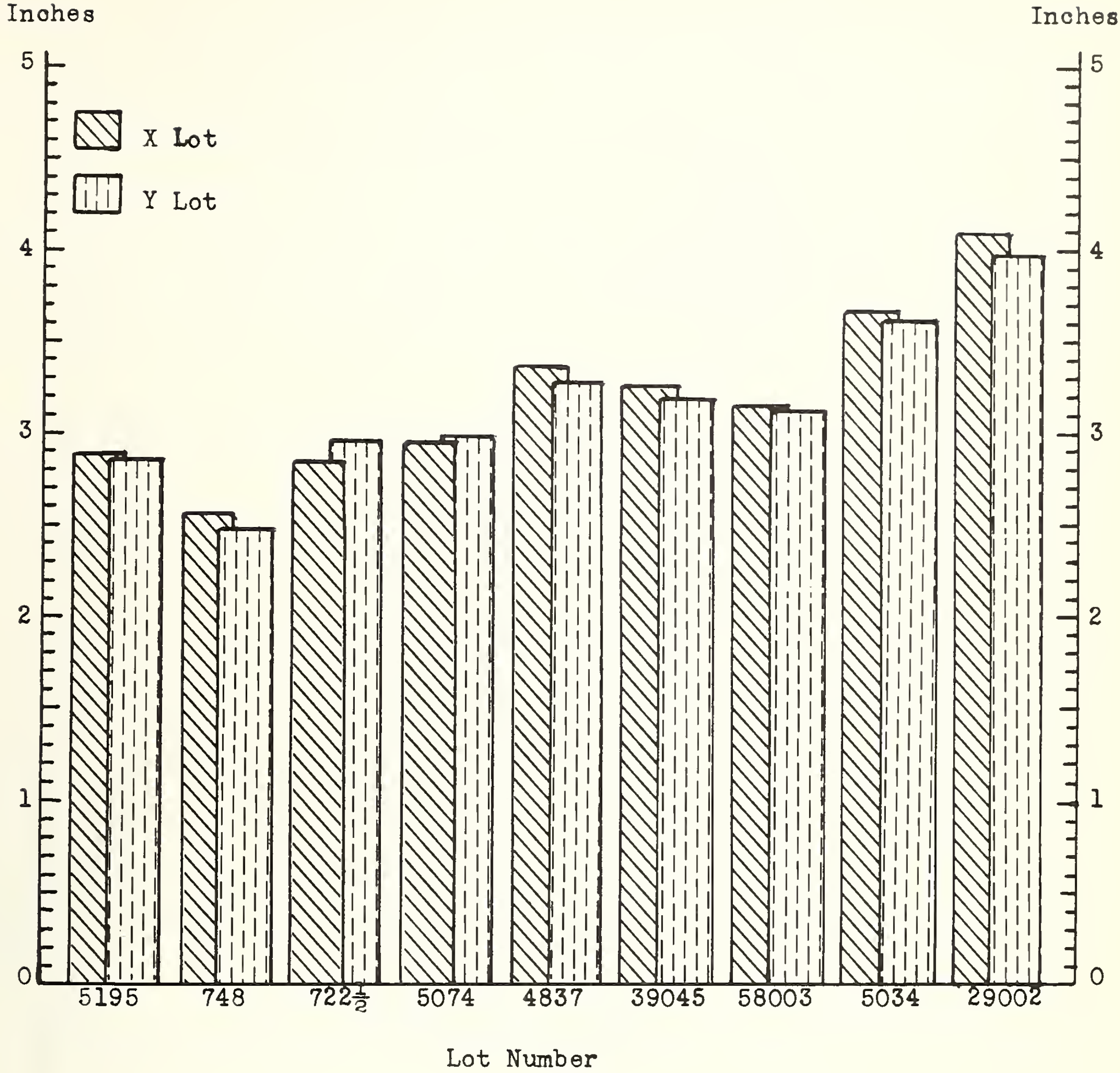


Figure 11.- The normal staple length of grease wool drawn from the split (X and Y) lots.

Wool staple sampling tool

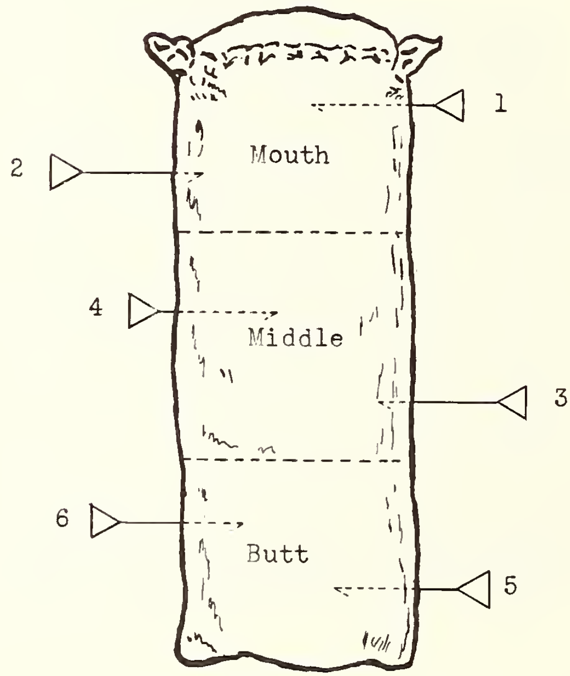


Figure 12.- Sampling pattern used in drawing grease wool staples from bags for length determination.

STAPLE CRIMP

Staple crimp is the natural waviness or curl occurring in the fibers within a staple or lock of wool.

Staple crimp, in general, and the number of crimps per given length of fiber, in particular, are indicators of fineness, and are used by many wool buyers and wool graders and sorters to aid in the assessment of fineness or grade. Generally, the more crimps per inch, the finer the wool.

Investigations are being made by various researchers into the precise effect crimp plays in processing wool into yarn and fabric, and in dyeing wool. Certain findings are suggesting its importance; however, the purpose of the crimp studies reported here was to relate the more visible characteristics of the staple crimp of grease wool, such as number of crimps per inch and crimp type, with average fiber diameter and grade.

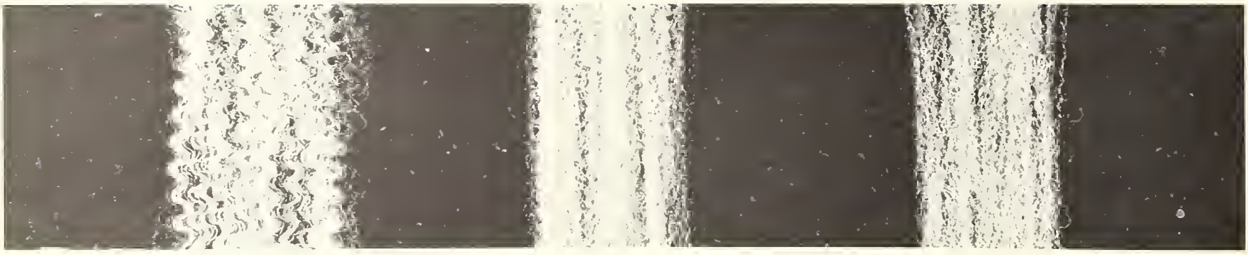
Sampling and testing grease wool for crimp determinations.--The grease wool staples used for length determinations were also used for crimp determinations. Crimp measurements were made before the length measurements. The number of crimps per inch was measured at the middle of the staple. A card with a one-inch-long notch cut at the edge was placed along the middle of the staple and the crimp crests within the notch were counted.

Crimp type was determined by subjective judgment by comparing the grease wool staples to physical guide samples (see figure 13) portraying three types of crimp, namely, bold, intermediate, and dim. These terms more or less describe the appearance of the crimp. For example a crimp of the bold type has a conspicuous waviness with a pronounced depth of wave. The crimp of the intermediate type is well defined but does not exhibit as deep a waviness as the bold type. The crimps of the dim type are only dimly visible.

The number of crimps per inch was measured and estimates for crimp types were made from 120 staples for each of the 46 lots. The average number of crimps per inch and the percentage of different crimp types observed were calculated for each lot.

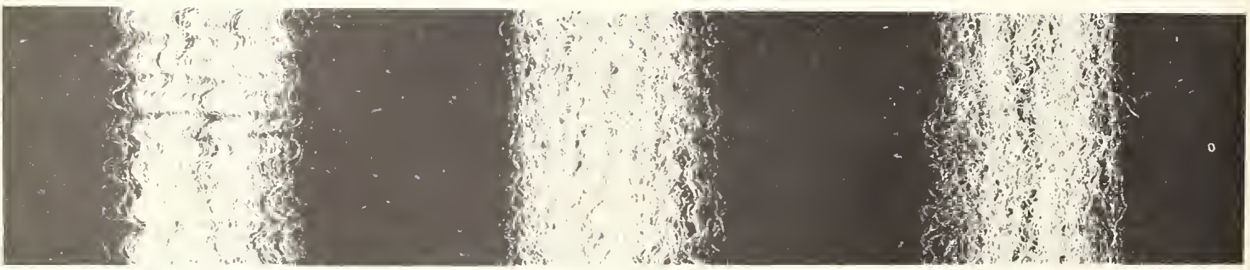
Comparison of staple crimp and crimp type with C.C.C. grade classification.--Data on measurements for average number of crimps per inch and the percentage of different crimp types in each lot are presented in tables 17 and 18. Also listed in these tables are the CCC grade classifications and the measured fineness of the raw wool.

Crimp-per-inch data in these tables and also in figure 14 appear to fall into distinct divisions according to CCC grade classifications, with only slight overlapping in crimps per inch between grades. As the grades become coarser there are fewer crimps per inch and the average number of crimps per inch decreases, by 2 to 3 crimps, as the grades drop from fine to coarse.



Bold Intermediate Dim

Fine Grade Wools



Bold Intermediate Dim

Medium Grade Wools

Figure 13.- Guides portraying three types of crimp used in this study.

Table 17.--Number of crimps per inch, crimp type, C.C.C. grade classification, and measured fineness of raw wool by fine and 1/2 blood lots

C.C.C. grade classification	Lot number	Average number of crimps per inch	Measured fineness of raw wool 1/	Crimp types		
				Bold	Intermediate	Dim
			Microns	Percent	Percent	Percent
Fine,	5195X	13.8	22.10	1.7	50.0	48.3
64's	5195Y	13.5	22.60	2.5	49.2	48.3
and	5151	13.1	22.00	10.8	35.8	53.4
finer	748X	13.8	23.50	3.3	50.0	46.7
	748Y	13.6	22.97	7.5	44.2	48.3
	15637	15.2	21.60	1.7	45.0	53.3
	5222	14.0	22.70	1.7	41.7	56.6
	KK2	14.2	22.75	6.7	42.5	50.8
	2816	15.2	21.08	1.7	22.5	75.8
	1042	14.8	22.08	0.0	43.3	56.7
1/2 blood,	722-1/2X	10.0	25.25	4.3	30.0	65.8
60's	722-1/2Y	10.5	25.95	6.7	34.2	59.1
and	P3B	10.6	25.33	8.3	30.0	61.7
finer	5074X	11.2	24.28	5.0	46.7	48.3
	5074Y	11.5	24.40	4.2	37.5	58.3
	4956	12.3	25.18	1.7	31.7	66.6
	2205	11.4	24.78	2.5	28.3	69.2
	5571	11.1	25.65	3.3	50.0	46.7
	5432	11.8	25.10	2.5	35.0	62.5

1/ Measured fineness of raw wool, represented by the average fiber diameter of 1-1/4-inch side core samples.

It can be seen from figure 15 that there is an inverse relationship between the average number of crimps per inch in the staple and the average fiber diameter of the raw wool; that is, as the average diameter becomes greater the average number of crimps per inch becomes fewer.

It is pointed out that the data of this staple crimp study are on a lot basis, determined by measuring 120 staples per lot. Also much of the reported crimp work has been on a single fiber basis, and the staple crimp characteristics are not necessarily the same as those of the single fibers within the staple. It is also emphasized that while the data relating staple crimp to grade and average diameter appear significant when the complete range of grades and diameters is considered, nevertheless crimp should not always be accepted as a criterion of the degree of fineness, especially within limited gradations of fineness.

Table 18.--Number of crimps per inch, crimp type, C.C.C. grade classification, and measured fineness of raw wool, by 3/8 blood, 1/4 blood, low 1/4 blood, and common and braid lots

C.C.C. grade classi- fication	Lot number	Average number of crimps per inch	Measured: fineness: of raw wool 1/	Crimp types: Bold	Crimp types: Inter- mediate	Crimp types: Dim
			Microns	Percent	Percent	Percent
3/8 blood, 56/58's	4837X	9.8	25.48	4.2	20.8	75.0
	4837Y	9.8	26.60	3.3	35.8	60.9
	39045X	9.7	28.43	4.2	23.3	72.5
	39045Y	9.2	29.38	1.7	39.2	59.1
	58003X	9.6	29.52	10.0	14.2	75.8
	58003Y	8.4	28.75	5.8	40.0	54.2
	6	9.3	27.95	6.7	34.2	59.1
	1041	9.9	26.95	5.8	45.8	48.4
	39151	8.7	28.40	4.2	24.2	71.6
	4023	9.1	30.07	3.3	10.0	86.7
1/4 blood, 48/50's	5034X	7.9	28.90	15.0	28.3	56.7
	5034Y	7.2	28.75	11.7	36.7	51.6
	255	7.9	29.60	7.5	40.0	52.5
	53265	9.1	26.02	5.8	31.7	62.5
	29002X	6.2	33.30	9.2	34.2	56.6
	29002Y	6.8	32.73	9.2	44.2	46.6
	39338	6.5	31.88	11.7	37.5	50.8
	52113	8.6	31.55	4.2	37.5	58.3
	55015	8.1	30.50	8.3	31.7	60.0
	120D	6.3	31.80	14.2	43.3	42.5
Low 1/4 blood, 46's	110E	3.9	33.52	6.4	44.9	48.7
	210E	5.0	31.30	21.7	45.8	32.5
	16851	6.3	30.55	14.2	33.3	52.5
	2-200E	4.2	33.78	26.7	40.8	32.5
	200E	4.6	32.82	22.5	58.3	19.2
Common and braid	2-200G	3.1	35.35	23.3	48.3	28.4
44,40,36's	100G	2.9	36.68	20.0	38.3	41.7

1/ Measured fineness of raw wool, represented by the average fiber diameter of 1-1/4-inch side core samples.

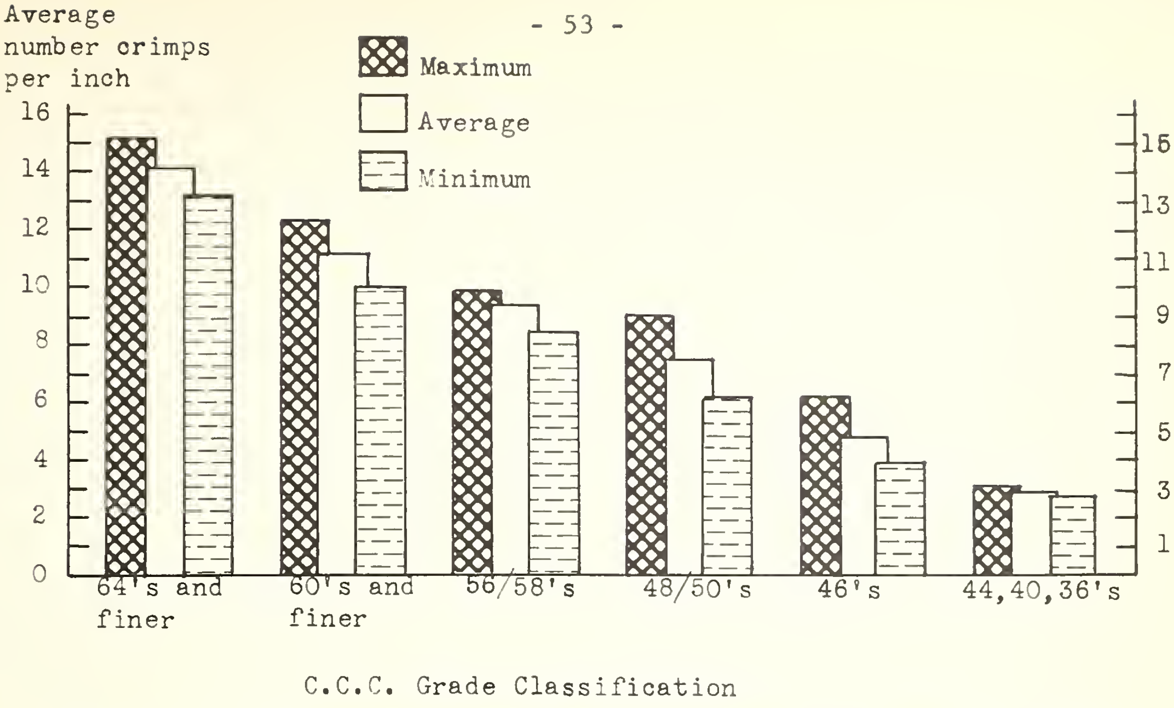


Figure 14.- The maximum, average, and minimum mean number of crimps per inch observed from lots of the various C.C.C. grade classifications.

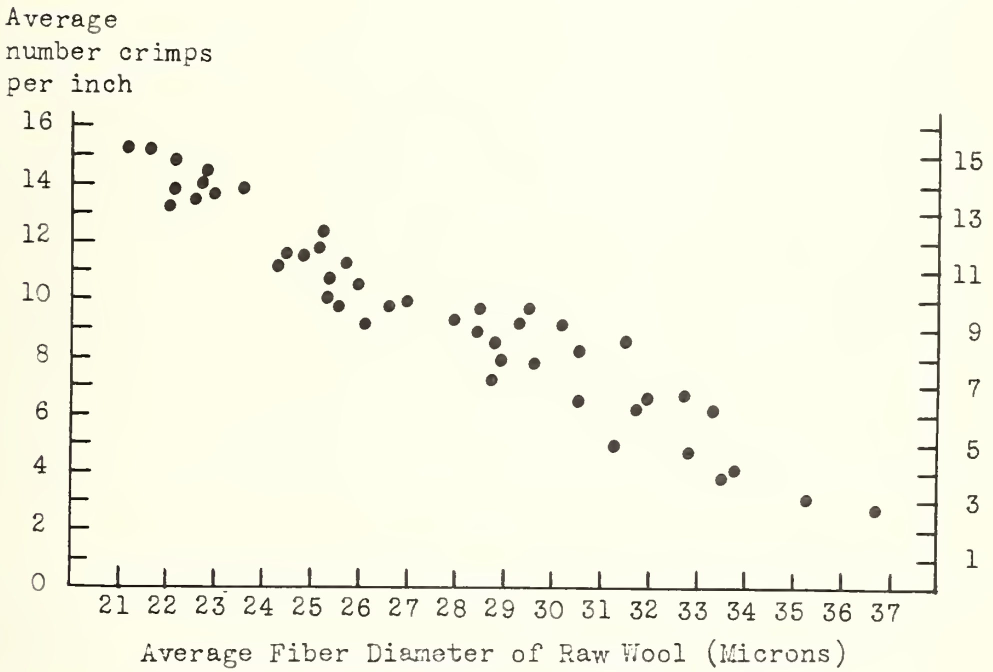


Figure 15.- Scatter diagram showing the relationship between average number of crimps per inch and average fiber diameter of raw wool.

NOILAGE OR WASTINESS

The term noilage is a percentage value representing the relationship between the weight of noils combed out of a given lot and the sum of the weights of the tops obtained and the noil combed out.

In the evaluation of wool in the grease, noilage refers more or less to wastiness. Generally, a wool is thought of as being wasty or as having a high noilage when the fibers are short, weak, or tangled and show an exceeding amount of tippiness, as well as being open or weathered and lacking in condition. These attributes are objectionable in processing since they will result in a high percentage of wastes and noil, these products being of less value than the main products. Noils are the short fibers separated from the long wool in the combing process.

The determination of the degree of noilage or wastiness of raw wool is solely subjective, and is dependent upon the knowledge of the individual estimating this characteristic. After the wool has been combed into top the percentage of noilage and the percentage of wastes can be calculated from combing reports.

The noilage as determined by processing and estimates of noilage or wastiness made by the industry committee.--The noilage, as determined by processing the wools, is compared with the estimates of noilage or wastiness made by trade members in table 19.

The trade members estimated the noilage or wastiness as being either low, medium, or high. It is apparent from the data of this table that the estimates made by trade members were not unanimous as to the degree of noilage or wastiness of the various wools. In some cases there are indications, however, that these estimates detected the wools that had an extremely high percentage of noilage and some wools with a lower percentage of noilage.

The data in table 19 indicate that there is a noticeable range in noilage among the lots within the various grade classifications and a definite overlapping in amount of noilage between the grades. For the most part higher noilage rates occur in the finer and shorter wools than among the coarser and longer wools; yet there were lower noilages reported for some fine wools that were French combed than some coarse wools that were Noble combed. The data further indicate that there may be a closer relationship between noilage and length than between noilage and grade.

The effect of different types of combing on percent noilage.--The noilage figures for the 9 lots that were divided and combed on Noble and French combs at the same mill are presented in figure 16. It appears that percentage of noil is affected by different types of combing. The Noble-combed wools of all 9 lots were higher in noilage than the French-combed wools. In fact the average noilage of the Noble-combed portions was 12.44 percent as compared to 8.41 percent for the French-combed wools.

Table 19.--Estimates of noilage or wastiness by trade members and percent noilage as determined by processing

C.C.C. grade classification	Lot number	Percent noilage		Number of trade members estimating noilage or wastiness as:		
		Noble	French	Low	Medium	High
Fine,	5195X	12.24	8.71	3	3	
64's	5195Y	12.66	7.78	3	3	
and	5151	16.15		3	6	
finer	748X	13.79	11.98	1	4	
	748Y	12.30	7.91	1	4	
	15637		13.14	3	3	
	5222		11.29		4	2
	KK2		12.25	1	4	
	2816		18.74			8
	1042		18.55	1	1	1
1/2 blood,	722-1/2X	11.35	8.03	4	4	
60's	722-1/2Y	13.24	10.22	4	4	
and	P3B	10.30		2	4	
finer	5074X	10.53		4	2	
	5074Y	12.44	7.07	4	2	
	4956		9.89			3
	2205		12.05	1	4	1
	5571		7.49	2	3	1
	5432		9.08		5	1
3/8 blood,	4837X	10.28			7	2
56/58's	4837Y	12.93	8.05	3	2	
	39045X	13.12			8	1
	39045Y	13.63			2	3
	58003X	10.99	5.94		7	2
	58003Y	9.27			4	
	6	14.16				
	1041	13.36		2	1	
	39151		7.89	1	3	2
	4023		9.05		1	8
1/4 blood,	5034X	11.57		2	4	3
48/50's	5034Y	7.62			5	
	255	11.42				
	53265	10.32		5	1	
	29002X	10.24			8	1
	29002Y	11.56		3	2	
	39338	10.65		1	6	2
	52113	16.31			5	2
	55015	10.12		1	8	
	120D	8.70		2	2	
Low 1/4	110E	8.14		3	2	
blood	210E	10.07			1	1
46's	16851	10.36		2	7	
	2-200E	8.62		1	2	
	200E	9.36			2	1
Common and	2-200G	8.89		3	1	
braid,	100G	9.02		4	4	
44,40,36's						

The noilage figures for the French-combed wools may be slightly misleading when compared to those for the Noble-combed wools. In addition to the regular noil there is a waste product in French combing known variously as brush waste, French burry, shoddy, or short noil. This waste is usually disregarded by the mills in the calculation of noilage in French combing, but it is definitely a noil carrying somewhat more vegetable material than the regular noil. If the weight of the brush wastes were added to the weight of the noil in calculating the percentage of noil, the average noilage of the French-combed lots of this comparison would be increased from 8.41 percent to 9.31 percent. However, the addition of the brush waste does not account for all the differences observed between the percentage of noilage for French- and Noble-combed lots.

The apparent differences in amount of noils removed during combing by the two systems seemed to result in but small differences in fineness of top. While the differences in length of top produced were small, the Noble-combed top was slightly longer than the French-combed top. This indicates that perhaps more of the short fibers were removed from the Noble-combed top, resulting in a longer average fiber length.

The effect of combing at different mills on percentage of noilage.--The influence of combing by different mills on the noilage is shown in figure 17. For the 9 original lots that were split into halves, data indicate that noilage is affected by the mill combing the wool. The noilage of the wools combed at mill number 1 was usually less than mill number 2 or mill number 3. While the differences in fineness between the tops produced from the same original lot at two separate mills was very small, the length of top produced seems to be affected by the amount of noil removed. The length of top produced by mill number 1 was longer than that produced by either mill number 2 or mill number 3.

SOUNDNESS

Soundness has to do with the strength of wool. A sound wool is one which is strong in fiber. An unsound wool is made up of fibers that are weak throughout, or of fibers with a tender area or distinct break. Environmental and nutritional conditions and the state of health of the sheep are the main factors which may cause weak wool. When combed into top an unsound wool will usually produce a higher percentage of noils and wastes than a sound wool.

In the visual appraisal of wool the soundness or strength characteristic is usually determined by stretching the staple and snapping it with a finger. The soundness is then estimated by the "ring" of the staple or the force required to rupture the fibers.

The estimates of soundness made by the trade members are presented in table 20. The wools examined were estimated as being either sound or unsound. It can be seen from the estimates that most of the lots were considered to be made up of sound wool, and that opinions vary as to whether a wool is sound or unsound. These results indicate a need for more objective means for evaluating this characteristic.

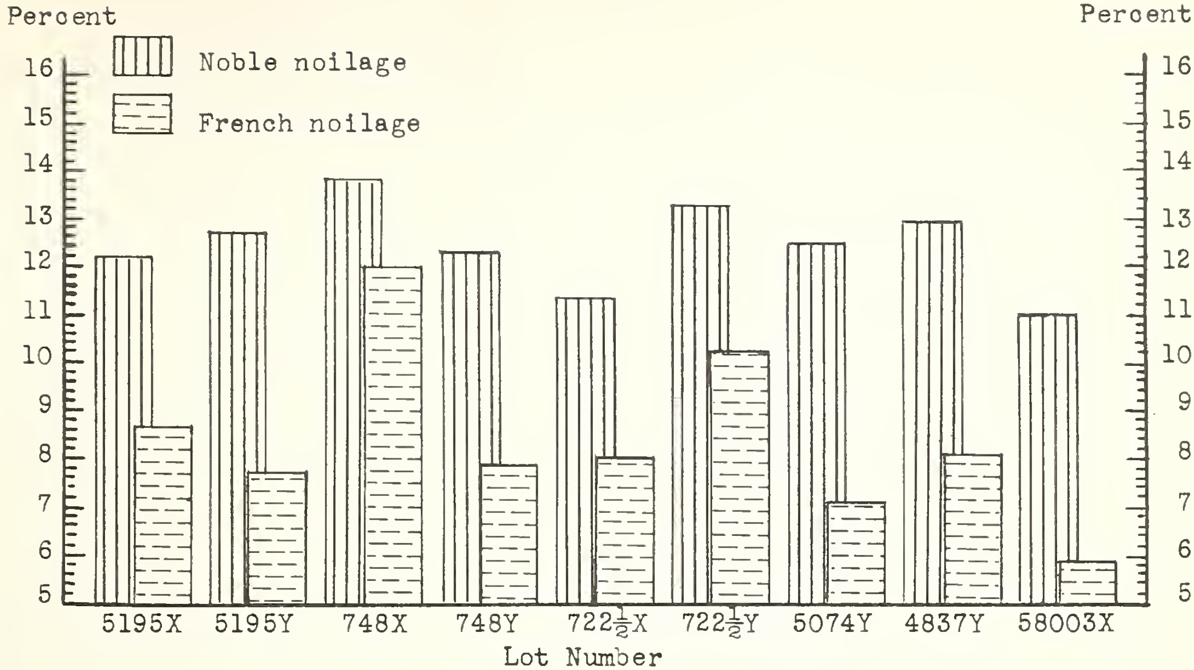


Figure 16.- The percentage of noilage of wools of the same lot, Noble and French combed.

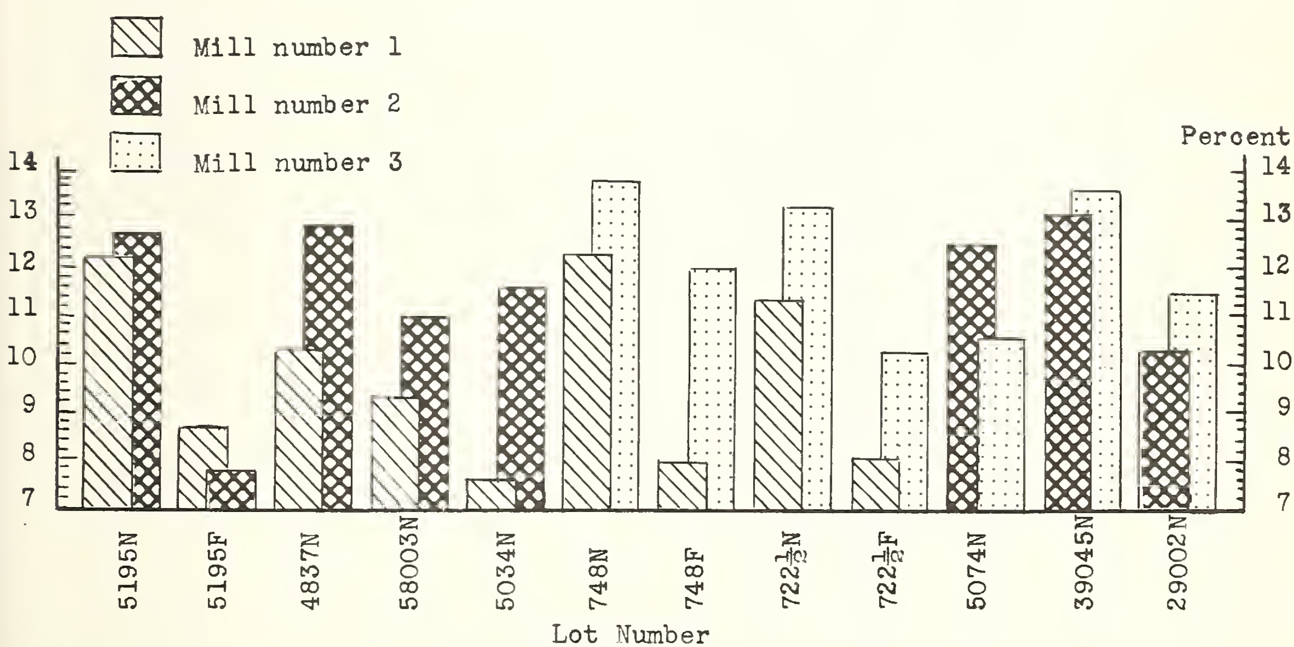


Figure 17.- The percentage of noilage of wools from the same original lot, Noble or French combed at different mills.

Table 20.--Estimates of soundness made by trade members, by lot

C.C.C. grade classification	Lot number	Number of trade members estimating soundness as: Sound	Unsound
Fine,	5195X and Y	6	
64's	5151	8	
and	748X and Y	6	
finer	15637	6	
	5222	5	1
	KK2	6	
	2816	4	5
	1042	3	
1/2 blood,	722-1/2X and Y	6	
60's	P3B	6	
and	5074X and Y	6	
finer	4956	1	2
	2205	6	
	5571	6	
	5432	6	
3/8 blood,	4837X	9	
56/58's	4837Y	6	
	39045X	7	1
	39045Y	4	
	58003X	9	
58003Y	58003Y	5	
	1041	3	
	39151	6	
	4023	5	4
1/4 blood,	5034X	8	1
48/50's	5034Y	5	
	53265	6	
	29002X	8	
	29002Y	6	
	39338	9	
	52113	6	
	55015	8	1
	120D	5	
Low 1/4	110E	5	
blood,	210E	2	1
46's	16851	9	
	2200E	4	
	200E	3	1
Common and	2200G	4	
braid,	100G	9	
44,40,36's			

CONDITION

Condition refers to the degree of yolk and foreign matter in wool. Wool that is heavy in condition usually yields less clean wool when it is scoured than a wool that is light in condition.

The industry committee evaluated the lots as being light, average, or heavy in condition. Their estimates are arranged in table 21. While the trade members differed among themselves as to the degree of condition within a lot, the data show that their estimates for condition were in relation to their estimates of yield. Those lots in which the majority estimated the wool as being heavy in condition had a lower top, noil, and waste yield than the average top, noil, and waste yield for the grade. Also those lots estimated as being light in condition had a higher top-noil-waste yield than the average for the grade.

COLOR AND CHARACTER

The presence in grease wool of color that cannot be removed in the normal scouring operations is usually objectionable.

Seldom is scoured wool really a true white. It is more of a light ivory or a cream color. A yellowish cast is the most prevalent color in the majority of wools. The pigmented fibers such as brown, black, or grey are objectionable, and when mixed with so-called white wool lessen the value and limit the use of the entire lot. The popularity of the light and pastel shades in wool textiles has made color in wool a more serious consideration than in earlier years. Color is more objectionable in the finer grades than in the medium and coarser wools.

The precise interpretation of the meaning and use of the term "character" differs widely. Generally, it has been thought of as describing the distinctiveness and uniformity of staple crimp which in turn makes the wool more attractive to the eye. However, as color and character are used together in this study, their evaluation has more than likely included all the characteristics of wool which make the lots attractive.

The trade members estimated the color and character of the lots they inspected as being either good, average, or poor. These estimates are given in table 22, and as was the case with other evaluations, opinions varied.

Table 21.--Estimates of conditions made by trade members, by lot

C.C.C. grade classification	Lot number	Number of trade members estimating conditions as: Light	Average	Heavy
Fine, 64's and finer	5195X and Y		6	
	5151	5	4	
	748X and Y			6
	15637		6	
	5222		1	5
	KK2	4	2	
	2816			9
	1042		1	2
1/2 blood, 60's and finer	722-1/2X and Y	5	1	
	P3B	3	3	
	5074X and Y	2	4	
	4956		1	3
	2205	3	3	
	5571	4	2	
	5432	2	4	
3/8 blood, 56/58's	4837X		8	1
	4837Y	3	3	
	39045X	1	8	
	39045Y	3	1	
	58003X	2	7	
	58003Y	1	4	
	1041	3		
	39151	3	3	
	4023	8	1	
1/4 blood, 48/50's	5034X		1	8
	5034Y		1	4
	53265	4	1	
	29002X	3	5	
	29002Y	4	2	
	39338	1	6	2
	52113	3	3	
	55015	6	3	
	120D	3	3	
Low 1/4 blood, 46's	110E	3	3	
	210E		4	
	16851	1	6	2
	2200E	2	2	
	200E	3	1	
Common and braid, 44,40,36's	2200G	4		
	100G	5	4	

Table 22.--Estimates of color and character made by trade members, by lot

C.C.C. grade classification	Lot number	Number of trade members estimating color and character as: Good	Average	Poor
Fine 64's and finer	5195X and Y	2	4	
	5151	7	2	
	748X and Y		5	1
	15637	2	4	
	5222		3	3
	KK2	5	1	
	2816			9
	1042		1	2
1/2 blood, 60's and finer	722-1/2X and Y	5	1	
	P3B	3	3	
	5074X and Y	2	4	
	4956			4
	2205	3	3	
	5571	4	2	
	5432	5	1	
3/8 blood, 56/58's	4837X	1	7	1
	4837Y	4	2	
	39045X		7	2
	39045Y	2	2	
	58003X	2	6	1
	58003Y	3	2	
	1041	3		
	38151	3	3	
	4023		7	2
1/4 blood, 48/50's	5034X		5	4
	5034Y		5	
	53265	5	1	
	29002X	2	3	4
	29002Y	3	3	
	39338		7	2
	52113	2	4	
	55015	6	1	2
	120D	2	4	
Low 1/4 blood, 46's	110E	3	3	
	210E		4	
	16851	1	7	1
	2200E	3	1	
	200E	3	1	
Common and braid 44,40,36's	2200G	4		
	100G	5	4	

DIGEST

The major physical properties influencing the value and utility of wool as a textile fiber are its yield of clean fibers, and its fineness and staple length. Visual inspection for these properties is the usual basis for preparation and sale. Since this inspection operation is performed under varying conditions, there are often differences of opinion as to the accuracy of appraisals made by graders, handlers, appraisers, and buyers. In order to provide a more accurate and consistent method of estimating the value of wool, laboratory sampling and testing methods have been developed for the assessment of its physical properties.

This is a report on studies made to determine the accuracy of visual appraisals for grade classifications and yields. These studies were made also to determine the adequacy of sampling and testing methods used for the evaluation, assessment, and standardization of certain wool fiber properties.

Included in this study are data resulting from the sampling, testing, and mill processing of 46 lots of Commodity Credit Corporation wool of various kinds and grades that were acquired under the price support programs during 1952 and 1953. Three mills recognized in industry as quality processors scoured, carded, and combed the raw wool, totaling approximately 607,000 pounds, into wool top. The object was to see how visual appraisals made by Government appraisers and a committee of industry wool men, and laboratory tests of the physical properties of the grease wool compared with the actual products resulting from the conversion of the grease wool into top.

Other factors normally considered in determining the value of a lot of wool were examined. They were as follows: staple length, staple crimp, noilage or wastiness, soundness, condition, color, and character. Also considered were the influence of different types of combing (Noble and French), and the influence of combing at different mills on top-noil-waste yield, the grade and length of top, and the noilage of wools of the same original lot.

Mill top-noil-waste yields, adjusted to standard conditions, were considered to be the best base to use for comparisons in evaluating the accuracy and observing the fluctuations of clean wool yield as determined from core samples drawn with tubes of various sizes and by using different sampling patterns.

On the basis of the data in this study, it was determined that clean wool yield based on samples drawn with the 1-1/4-inch coring tube, using either side-core or end-core sampling patterns, more accurately reflected the actual mill top-noil waste yield of the lots than did yields based on samples drawn with the 3-inch or 3/8-inch pressure coring tubes. They also proved more accurate than did the visual appraisal method.

Samples drawn with the 3-inch and the 3/8-inch pressure coring tubes led to overestimates of the yield of a lot as compared to the actual mill top-noil-waste yield.

Yields based on 1-1/4-inch side core samples were slightly less on the average than those made on the same basis 2 years previously when the lots were accepted into the support programs of 1952 and 1953. This surprisingly small difference was attributed mainly to changes in weight during storage.

The data demonstrated that lots will either gain or lose some weight during storage; however, on the basis of averages, the change in net grease weight was very slight for 39 of the 46 lots.

The findings suggest that further study is needed to develop better sampling methods to test for moisture content in commercially scoured wool.

The reported findings show that the grade classifications made by appraisal, in connection with price support operations during 1952 and 1953, were reasonably accurate.

There was a noticeable tendency for the appraised grade to be finer than the grade of top produced. However, these visual appraisals were made by non-technical methods and on the basis of visual wool standards under which no physical grade measurements were specified; they compared very closely with the estimates of grade made by members of an industry trade committee.

The use of measurement techniques and the application of the new proposed standards and specifications for grades of wool appeared to have good promise for assessing grade. The grades based on laboratory measurement of raw wool (core samples) were more consistent with the grade of top produced from these wools than were the visual estimates of grade made by Government appraisers or by the industry committee.

The changes taking place in fineness when raw wool is processed into wool top follow very closely the pattern observed in previous work. The finished top is coarser than the product from which it is combed. The spread in fineness between top and raw wool increases as the raw wool becomes coarser. The noil is finer than either the top from which it is combed or the product being combed.

All the wools used in this study were processed in their original graded condition. The findings suggest that further work should be carried out on wools that have been "skirted" in order to determine the effect the removal of skirts would have on the grade.

The measurement of grease wool staple length and the average fiber length of top indicated that the length classification appraisals made in connection with price support programs were substantially accurate.

Estimates of the average staple length, and the range in staple lengths within a graded lot, can be obtained with reasonable accuracy by using the techniques employed in this study.

The average normal or unstretched staple length of grease wool was found to be a better indicator of the average fiber length of the top than was the stretched staple length.

The lengths of grease wool estimated by the industry committee compared more closely with the average length of normal grease wool staples than with the average length of stretched staples.

The staple crimp-per-inch data appear to fall into distinct divisions according to C.C.C. grade classifications, with only slight overlapping of data between grades. As the average diameter of the wool becomes coarser the average number of crimps per inch becomes fewer.

The staple crimp data also reveal that while there appears to be a close relationship between number of crimps per inch and grade when the complete range of grades and diameters is considered, crimp should not always be accepted as a criterion of the absolute degree of fineness, especially within limited gradations of fineness.

It would appear from the study of the 9 lots of wool that were divided and combed on Noble and French combs within the same mill, that there was no top-noil-waste yield advantage for either type of combing within a mill, nor was there an apparent effect on the fineness of top produced by different types of combing.

However, the data did suggest that Noble combing produced a slightly longer top than did French combing and that the Noble-combed wools of all 9 lots were higher in noilage than the French-combed wools.

Nine of the original lots were split into half-lots of approximately equal size. The matching halves were combed at different mills. The testing results indicate that there was no important mill influence on fineness.

There were, however, suggestions of mill differences in top-noil-waste yield, and a consistent tendency for one mill to produce a longer top than the other mills; also, the noilage of the wools combed at this mill was usually less than that of the wools combed at the other mills.

The members of the industry appraisal committee were also asked to give their opinions as to the noilage or wastiness, soundness, condition, color and character of the grease wools they appraised. While the estimates made by this committee were not unanimous, there are indications that the estimates reflected the extremes of these characteristics.

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